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ABSTRACT

The Task Force on Women, Minorities, and the Handicapped in Science and Technology was established by the U.S. Congress in Public Law 99-383 with the purpose of developing a long-range plan for broadening participation in science and engineering. Public hearings were held in Albuquerque (New Mexico), Atlanta (Georgia), Baltimore (Maryland), Boston (Massachusetts), Chicago (Illinois), Kansas City (Missouri), and Los Angeles (California) between Fall 1987 and Spring 1988. The final report of the task force was produced in December, 1989. This document is the verbatim transcript of the public hearing. Co-Chairs Mr. Jaime Oaxaca and Dr. Ann Reynolds presided over the hearing. Following opening comments by Mr. Oaxaca, speakers at this hearing included: (1) Dr. Matina Horner; (2) Dr. Norma Ware; (3) Dr. Elizabeth McKinsey; (4) Dr. Patsy Dickinson; (5) Ms. Vivian Li; (6) Dr. Sheila Widnall; (7) Dr. Kenneth M. Hoffman; (8) Dr. Shirley McBay; (9) Dr. Elizabeth Ivey; (10) Dr. Millie Dresselhaus; (11) Dr. Gilbert J. Lopez; (12) Ms. Joanne Sherwood; (13) Dr. Christine Jones; (14) Ms. Andrea Shlipalz; (15) Ms. Marybeth Ruskie; (16) Dr. Raymond Kurzweil; (17) Ms. Bernice Boyd; (18) Elmer Bartels; (19) Dr. Valerie Crane; (20) Dr. Harlee Strauss; (21) Dr. Lilli Hornig; (22) Dr. Margaret Rossiter; (23) Dr. Gerald Holton; (24) Dr. Janice Button-Shafer; (25) Ms. Karen Henry; and (26) Ms. Phyllis Dohenian. (CW)

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TASK FORCE ON WOMEN, MINORITIES, AND THE HANDICAPPED IN SCIENCE AND TECHNOLOGY

PUBLIC HEARING

REPORT OF PROCEEDINGS of a public hearing of the Task Force on Women, Minorities and the Handicapped in Science and Technology held on the 7th day of April, 1988, at the Cronkhite Graduate Center, Radcliffe College, Cambridge, Massachusetts, and presided over by MR. JAIME OAXACA and DR. ANN REYNOLDS, CO-CHAIRS.

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Dr. Ann Reynolds, Chancellor
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MR. OAXACA: Good morning, everybody. Let me take this opportunity to welcome all of you to the public hearings on the Task Force on Women, Minorities, and the Handicapped in Science and Technology.

As all of you are aware, this is a Task Force that is addressing the issue of making our nation competitive in the out years and in upgrading the ability of our nation to produce students out of high school that can succeed in college and go on to advanced degrees, and to do it in a way that's going to bring back our nation as number one in the manufacturing technology fields where we have lost so much market share over the years.

The problem is one of filling up the pipeline on the K through 12 and having representation as it should be from the groups that historically have been underrepresented and groups that tragically are showing a diminishing number as time goes on at the very time that the demographics are showing that the numbers should go up.

So that's the problem that we're addressing. We're delighted to have all these very distinguished witnesses that will be giving their presentations, and we are particularly pleased to have as our first speaker someone who has been so participative in putting together all the resources for us here for this hearing, and it's my great honor and privilege to thank Dr. Matina Horner, the President of Radcliffe College, who's staff and herself have worked very hard with the folks on the Task Force to make this a very welcome occasion.

Let me state the ground rules before Dr. Horner gives us her testimony. We're allowed 10 minutes. After nine minutes, the witness will hear a bell that says you have one minute. At the end of the 10 minutes we expect the witnesses to finish their testimony.

Anyone who wants to testify, please fill out the cards and you will be allowed three minutes sometime during the day. If you could turn it in to Mildred. Mildred, could you please identify yourself. There is Mildred coming in right now, direct from Washington, D.C.

The testimony that we will hear is of paramount importance and we are very thankful for those people that have taken the time.

I would like now to introduce our first witness, the very distinguished Dr. Matina Horner. Welcome to the Task Force hearings.

DR. HORNER: Thank you, Dr. Oaxaca. I am pleased to be here to extend both my personal and the official greetings of Radcliffe College. We are especially pleased to welcome you to our campus and to participate in these hearings.

The challenge this Task Force has accepted could not be more closely linked to the founding purposes and continuing mission of the college.

Our charter obligates us to provide access to talented women to high quality education and to promote and facilitate their full participation and a contribution to our society and to the world community, of which we are all a part.

We look forward to the testimony here today and to the ultimate conclusions and recommendations of your report, and we hope to share some of our experiences at the college, both our frustrations and achievements.

The severe underrepresentation of women, minorities, and the handicapped in the American scientific and engineering communities, both within and outside the academy, as well as their absence from the pipeline of future scientists, engineers, and technical personnel, is by now well documented and contributes significantly to the growing concerns that within a decade the American work force will be running out of qualified, adequately trained people, especially in the sciences and technological--especially those with scientific and technological skills that are so sorely needed if America is indeed to grapple successfully with the competitive crisis in which it finds itself on the international stage.

When taken together with the deplorable dropouts from our schools and the illiteracy rate among those who do manage to graduate, these figures represent a tragic, inexcusable, if not criminal, neglect of our nation's human resources and most valuable assets.

It is the kind of neglect we can ill afford and one that places us at severe, long-term structural competitive disadvantage that no degree of ingenuity and creativity with regard to trade policy or capital formation will help us overcome.

The fact that in recent mathematical competition with students from nine other industrialized nations, Americans finished last is not comforting.

One wonders how many contests, how many reports of an imperiled generation in the nation at risk we will need in order to get the message.

To truly understand that we have failed to invest adequately in our nation's human resources or to develop the talents of those individuals, especially women, Blacks, Hispanics, and our disadvantaged citizens, whose particular disabilities are irrelevant to their ability to contribute significantly in the fields that we're concerned about today.

The time has come, it seems to me, to deal directly with the problems and issues at hand, put an end to our ongoing national tendency for denial and benign neglect of problems that we wish were not there.

To get beyond rhetoric and piecemeal approaches to problems that require sustained attention, sophisticated analysis, and a unified response attending to all aspects of the problem in an integrative and effective way.

To be effective in these areas, we will clearly have to, first of all, challenge longstanding but unfounded assumptions about the extent of interest and the level of ability present in members of the underrepresented groups.

What level of ability and interest they have in matters mathematical, analytical, scientific, technical, engineering, or computer-related seems to be much misunderstood.

We will also have to shift successfully from a general climate of unexpectation toward those in these groups who have the taste and talent for work or study in these areas to one of expectation, encouragement, and support, coupled with policies and possibilities for equal access to quality scientific and technical training and opportunity for which they are recognized to be suitably qualified, and secondly, for recognition of their efforts and promotion commensurate with their talents and achievements.

The support must be sustained all along the pipeline, not only at the point of entry, all the way from the prekindergarten to the post-doctoral.

And I do stop for a minute to stress the prekindergarten. I have--it is unusual for college educators to talk about the importance of support in health and nutrition for mothers and children before they get to school. But if we do not pay some attention and integrate our social, educational, and welfare policies, we will have children entering the pipeline underdeveloped and incapable of responding to whatever success we may have in improving our curriculum or school system or the training of our teachers.

And it is not lightly that I stress all along the pipeline, beginning with the nutrition of our mothers and children who are otherwise disadvantaged.

Otherwise the pipeline will continue to be clogged with irrelevant barriers and the talent deflected to other domains for all the wrong reasons.

My interest in these areas and my attention to it came while I was in college, a math and chemistry concentrator deflected by the attitude of a math professor who felt that women were not worthy of being educated or trained, no matter how talented they might have been; deflected from psychology later into administration, at least temporarily.

We continue to experience the wasteful and rather confusing boom and bust cycles if we don't pay attention to unclogging that pipeline and removing the kind of deflectors that exist.

The goal is to assure that those with the taste and talent for scientific and technological work will receive the kind of support they deserve to develop confidence essential for pursuing their interests and for developing their talents, which are so critical to the future strength of America's scientific enterprise, economic competitiveness, and ultimately our national security.

We cannot afford to continue to ignore and waste the talents of so many of our citizens.

I was intrigued in the mid-1970s that one of the issues of great concern, as Radcliffe sought to gain a policy of equal access admissions [INAUDIBLE] away from the four-to-one Harvard graduate ratio that had for close to a century governed the admissions policies of our institutions was the great concern about how this shift, what consequences and implications it would have for the science departments of the university.

Given evidence that there were relatively small numbers of women enrolled and came to us with adequate pre-college training in the sciences, and that those who did were deflected along the way from sustaining their interests in science--and you will hear later from one of our students about some of the factors that created that--led to some very rather active engagement with the help of a number of visionary corporations--IBM, Exxon, and the Ford Motor Company--to begin to encourage those who did have the taste and talent for science here to stay with it, and to stick with it all the way from giving them opportunities, using the funds for opportunities and direct research experience with women both within and outside the academy.

We didn't have very many women on the faculty here with whom they could work, and so we worked with women elsewhere to provide that experience, to give them recognition with science prizes, and a number of other things like inviting women scientists to come and work with them here.

It is clear, however useful those efforts were, that we needed to attend to the pre-college situation and to the post-doctoral problems that women face.

And so we developed a summer program in science for talented high schools students that you will hear about from my colleague shortly, and with the help of a couple of corporations, and later with the visionary and sustained support of the Office of Naval Research, post-doctoral fellowship program at our Bunting Institute that has had considerable positive impact, and you will hear about that from my colleague, my colleagues.

I hope to--that together, if we really want to make a difference and unclog the pipeline and remove those deflectors, we will have to attend to the full range of issues involved, including the complex social, economic, political, educational, and demographic realities that are part of the problem we are addressing.

And if the Associate Dean of the College, Norma Ware, could come up and say three words about our summer program, it would be very helpful.

DR. WARE: Three words it is because I know my time is very [BELL] short--[laughter]--two words.

The Radcliffe Center Program in Science is an eight-week intervention effort designed to encourage the persistence of young women in science by identifying [INAUDIBLE] science, girls, science at the high school level, and then providing them with an experience which we hope will increase their enthusiasm and their desire to persist in science at the college level and beyond.

I don't know how much more time I have here--maybe I should just get to the very end and say, well, we have--it's a combination of academic and extracurricular components that involve getting the students as much chance as they can to interact with role model women scientists at various levels.

And we do take--we do careful effort to evaluate the retention rate of our program alumni and the studies that we've done over the past several years at two and five year followups indicate that approximately 75 percent of our program alumni do go on to declare college majors in scientific areas.

DR. HORNER: And there has been a special emphasis to attract minority women in that program.

Norma, I see, has material here.

DR. WARE: Yes, I'll leave materials on the table that perhaps can give you more information.

DR. HORNER: And I would ask Beth McKinsey, the last few minutes, to introduce one of our current ONR science fellows.

DR. McKINSEY: I think we're about out of time. Let me just say the Bunting Institute gives fellowships for a year to do independent projects to women in science, as well as other fields of academics and the arts. It's a very multi-disciplinary community.

Patsy Dickinson, a biologists who is a fellow this year from the faculty at Bowden College, is here. I'm not sure she has any time left to testify.

DR. HORNER: She can say two words [INAUDIBLE].

DR. DICKINSON: I'm not sure what I can say in two words.

MR. OAXACA: Take your time. I think this is so important that we understand from the trenches what's going on.

DR. DICKINSON: OK, well, I think that Bunting Institute science program has a number of advantages. First of all, it does provide time, as well as some financial support for research materials for a year's research.

And it has advantage over some other programs in that it can take women at a variety of levels. I personally have been teaching at Bowden for four or five years and am going to be up for tenure when I go back in the fall, and feel that this sort of program will--for me at least--hopefully it will help me get tenure.

I know other women who are scientists--science fellows there now who are just immediately post-doctoral and who are using this as a way of getting into, into the job market.

So it has a number of [INAUDIBLE] over different levels.

In addition to just providing simply the time, the other thing that is very nice about the Bunting program in particular is that it provides an atmosphere--sort of a supportive atmosphere in which it is very conducive to doing research and to making progress in science.

And I think that this should be reflected both in our research at the Bunting Institute and when we go on, and that--there's a--this is absolutely for me the first time I've ever been around other women in science.

There is only one other woman on the Bowden faculty [INAUDIBLE] in science. And so to have a number of women in science is sort of a rather pleasant and unique opportunity.

And I think that it in fact is useful in sort of formulating ideas and ways to go in terms of both my own research and in talking to women students when I go back to Bowden [INAUDIBLE]--a quick summary of [INAUDIBLE].

DR. HORNER: I think what Patsy has described in her own experience, we have now over a quarter century of testimony and results that being given a room of their own, financial support, confidence of--confidence in your talent has bolstered the confidence and productivity of the women that have been able to then really go forward and contribute to their field, and serve as--I use the word role models in quotes--to provide encouragement for others and to increase their expectation about opportunities ahead.

MR. OAXACA: Thank you so much, Dr. Horner. I'm sure the panel has questions for you and your colleagues and we will open up the floor for questions on Dr. Horner's testimony and any other person that testified. Dr. Scadden.

DR. SCADDEN: I had a question for anyone who wants to answer it, I guess, regarding the summer program where you indicate that you have scientists come in and work with high school students. Where do the scientists come from who serve as the, I guess, part of the faculty and role models for the summer program?

DR. WARE: They come from various academic and professional contacts in the Boston area. We have developed, over a period of years, really quite a good supportive network with women scientists working in all kinds of professional settings and at the stage we draw on a number of those, or several of those.

DR. SCADDEN: How much time do they give during the summertime, and are they compensated for their time?

DR. WARE: They perform in various capacities. Some are guest lecturers, some are--do what we call career conversations, which are informal talks with the students about the work and life issues in science.

The people who perform in those capacities are compensated.

We also have the real [INAUDIBLE] that we're most excited about is our big sister program, where individual women, scientists volunteer to develop a one-on-one relationship with a student over the course of the entire eight weeks. Those individuals are not compensated.

DR. SCADDEN: Thank you.

MR. OAXACA: Dr. Jenkins.

DR. JENKINS: Dr. Horner, I believe the members of this Task Force would certainly agree with you that we need to give attention to the complete pipeline, from early childhood education through post-doctoral accomplishments.

But can you help us by sharing with us what it is we should recommend to get institutions of higher education to even deal with the current pipeline of the minorities who arrive at universities and who do not remain there, the retention problem, and particularly for Black youngsters?

How can we galvanize universities to work on that problem?

DR. HORNER: I think that one of the things that one should avoid is attempting to recommend a monolithic solution across the board. I have become sensitive that even within our own population, which is already selected, there are wide ranges of differences in what it takes to make a difference--their perception.

It matters which fields they are in--there's a very different set of issues.

Whether you are in the biological sciences or the physical sciences, and in computer is a very different issue altogether than any of the others.

So a tendency to avoid what we usually like to do--come up with monolithic solutions--won't work across the board. And that's hard work because it requires individual sensitivity and awareness of what the particular issue may be for an individual.

I think if there is any one common denominator that requires attention it is the building of the individual's confidence within the women's group.

One of the issues that came up recently with a minority student that I hadn't really confronted in the sciences before, who is now being courted quite heavily by graduate schools that want her, was a crisis of confidence that related to her identity with her family and friends and the neighborhood she came from, and what did that mean about her.

That is a whole psychological dimension that has not really been given as much attention as it might, that was--came very close to having her decide not to go to graduate school or to pursue her studies.

And that was really new for me and makes me think a little bit about what we might want to do to address that issue in the future.

I think things that we have done in getting--we have used the science prizes that we give as a two-edged sword, because we ask departments to nominate the women who qualified, and that gets faculty that have tended to ignore talent in women and minorities to really identify it.

It's even less important who actually gets the one or two financial prizes that go with the award as the overall effect of having faculty attend to identifying people of talent and then becoming committed to it, because once you write a letter of recommendation about why this woman or minority student is especially talented, you develop an attachment that goes forward.

So using the incentives and carrots you have are very useful. When we had funds for the Bunting Institute from Carnegie to support non-tenured faculty, one of the things we did with the same purpose was to ask for recommendations from the institution, but clearly we weren't going to be able to handle all the applications we got.

But the fact that a president of a university had to recommend a woman on his faculty meant that he was at least aware that there was somebody talented enough to be recommended for a distinguished fellowship and would put a few questions to the department that didn't promote it.

So I think it's that kind of creative and integrative thinking about what you are trying to do, as opposed to simply throwing money at a problem or having an award.

MR. OAXACA: Uh, Dr.--oh.

MS. HANSHAW: Do you have any information on the success of the intervention program for tenured [INAUDIBLE] granting either on your own programs or other programs? It seems to me that's a...

DR. HORNER: The tenure record of our--the non-tenured members of--who have held Bunting fellowships is a very spectacular record. It is well over 80 percent.

MR. OAXACA: Dr. Adams.

DR. ADAMS: I have a couple of questions to ask about the Bunting thing, because of all the testimony we've heard, I think this probably comes as close to faculty development in terms of what we want to do.

One, what is the--what kind of stipends do they get?

Number two, across what disciplines? Are they connected just with your institution or are they combined within the city here?

DR. HORNER: The current stipend--we have three different stipends--the current stipend for the Bunting fellowship core program funded by the Radcliffe endowment is $17,900.

We have some $20,000 fellowships that are externally funded.

The--virtually every discipline is represented. It is harder to get a Bunting fellowship than it is to get into Harvard or Radcliffe colleges.

The level of application [INAUDIBLE] activity is one of those very difficult tasks. Some years you have more historians or more psychologists or more writers than not.

The science community of scholars, we try to arrange for contacts with labs relevant to their fields at Harvard and MIT and Woods Hole, or whatever their discipline is. We want to assure--we do not have laboratory facilities at the Bunting Institute, and for those scientists who are in the midst of their laboratory work we try to make appropriate arrangements for them.

MR. OAXACA: Dr. Horner, one of the areas that you mentioned that the Task Force is significantly concerned about--as we all know, the demographics are changing in our nation, and if you look at some of the numbers you could make the case that 85 percent of our nation in the out years will be made up of the so-called minorities that this Task Force is addressing.

Yet that same 85 percent has a dismal and a diminishing yield going into the BS level or attempting to get the BS level.

So the Task Force has to address it right from the point that you mentioned, which was the prekindergarten, and it goes all the way into parent accountability and teacher accountability and the quality of the teachers, and getting rid of the stereotyping of--that it is an intellectual capacity problem, as opposed to a cultural discipline problem, perhaps.

In a short time, and if you could find to give added testimony based on your significant experience, I would surely like to hear some of your thoughts on what the Task Force might do to address recommendations that get right down at the beginning of the problem to fill up the pipeline, because if you are going to get into the issue of quality, you have to have a larger set of folks to draw from.

DR. HORNER: I think that's--it's become so increasingly clear, as the recent CED report has dramatized and that recently in Massachusetts one of the recommendations we made--and this is particularly pertinent to the large representation of members of this group in our inner-city schools where dropout rates are of the order of magnitude that, greater than 50 percent often.

That unless we address that I don't see that we have a prayer, and recent recommendations have really been pressing the reintroduction of Head Start, the strengthening of the WIC program, and it really is an unusual group of people who are saying, you have to do this for educational purposes.

It is not just being nice and worrying about equity issues or health, that it is our self interest to attend to the complex uncoordinated health, education, and welfare policies of this land, particularly in our inner cities where the bulk of America's future talent and work force really is.

Interestingly enough, the partnerships between corporate America and higher education are beginning to at least be heard. I think it's stunning--we knew these facts many years ago. We really simply did not wish to address them.

But I think the engagement of corporate America in this and the force of a Task Force like this, putting some weight behind those recommendations for pipeline purposes would be enormously helpful.

MR. OAXACA: Thank you so much for your testimony, Dr. Horner.

DR. HORNER: Thank you.

MR. OAXACA: And thank you again for being our host and for all the help you've given us. We look forward to some very productive testimony. Thank you to your colleagues also.

At this time, I would like to welcome Ms. Vivian Li, Advisor to Governor Dukakis--who is the advisor to the governor on women's issues, the Commonwealth of Massachusetts. Welcome to our public hearings, Ms. Li, and I understand your boss is out doing something else these days--[laughter]--but we're sorry he couldn't make it. Jesse told me to say that. [laughter]

MS. LI: Thank you very much. I bring greetings from Governor Dukakis. He had really wanted to be at this hearing. Unfortunately, as you have indicated, he had a previous commitment.

We think it is particularly appropriate that your hearing be here in the Boston-Cambridge area, given the high concentration of academic institutions we have here.

Let me move onto the subject at hand. Unfortunately, as you know, we have a mixed story to tell. As the National Science Foundation and others have documented, women, Blacks, and Hispanics continue to be underrepresented in the sciences and in engineering.

While their numbers have been increasing in the sciences and in engineering more rapidly than the rest of the population, they still lag considerably behind the majority.

In fact, when I called up my colleagues in the

Department of Employment Securities and also at our Board of Regents of Higher Education, both agencies told me that they didn't have any statistics on the number of women in sciences or in engineering because it was such a small percentage.

I think that's a really sad commentary.

The participation of women and minorities in sciences are like those that we find in other, what we call non-traditional fields. Part of it has to do with training. That is, the low participation of women and minorities in pre-science and math courses.

And also their low enrollment in undergraduate science and math courses.

And if you will indulge me for a minute, I would like to refer back to my own experiences as a student at Barnard College more than 10 years ago, which is considered a fairly progressive school.

When I was there, we did not have our own math department. In order for a woman to take a class in calculus or any of the other math areas, we had to go across the street to Columbia.

And I very often now wonder what type of message that sends to women. That is, a school like ours, which was designed to foster women, the fact that we didn't have our own math department, I think, sends a certain message.

The other thing that we notice is that after women graduate from science and engineering courses, they still lag considerably behind men. They tend to earn less than men who have comparable experiences, and they also tend to have less experience and less seniority, and as a result currently they still don't get some of the best positions that are available.

Now let me go on to some of the good news. Realizing that there needs to be what we call a lot of catch-up, many of the academic institutions in Massachusetts are finally focusing attention on what they can do.

Paula Levinson, the Dean of Engineering at Northeastern, has initiated programs to attract women into engineering.

At MIT, the alumni association has established a program whereby women graduates go out into the community and into high schools, serving as role models, encouraging women to take more courses in the sciences and in math, and also to consider applying to schools like MIT.

I think that unless we have the support of faculty, administrators, guidance counselors at the high school level, it is very difficult, even today, for a high school girl to think that the opportunities to go to a school in engineering are possible.

I think we need to give additional attention to that.

My office is looking very strongly at setting up programs, through the Boston public schools, to encourage women into non-traditional fields, be it sciences or engineering or in construction.

Here in Massachusetts, we will have approximately a $10 billion construction boom over the next 10 years, and one of the things that I am particularly interested in is being sure that women and young women have an opportunity to benefit from that type of boom.

Not only will we see increases in jobs in construction, but also in what we call construction-related activity, such as in engineering, in environmental management, in economics, and so we really need to encourage women to get into the pipeline, so that they will be able to take advantage of that type of growth.

I also wanted to mention, when I was at Princeton-- and this is in response to a question that someone here asked, one of the things that the university did, and I think did quite effectively, to encourage minorities to stay in school, is that they provided a type of support system where they provided free tutoring to students where necessary, where they put together groups of students who needed a little bit more assistance would meet on a weekly basis, and it would be a combined tutoring system and also a support group.

And I think efforts like that are particularly important when students get to college, because it's not enough just to get the student into the school. We really need to keep them there, and if it means additional tutoring, or support, we need to be able to do that.

And we need to do that without embarrassing the student. So I think a school like Princeton, which really made an effort to at least do that, if that can be duplicated in other universities as well.

On the state level, we have something known as our Centers for Excellence, which is set up under our Executive Office of Economic Development. And these centers are designed to look at new technologies and at ways in which we can involve women and minorities.

In particular, we see biotechnology, marine technology, and solar electricity as areas that will be growth industries in the future for which we hope to involve women and minorities, and our office will be working very closely with those sectors.

In conclusion, let me say that we are very honored that you have chosen Massachusetts as one of your hearing sites. We hope you will have a very successful hearing, and please let us know if there is anything further that we can do to help.

MR. OAXACA: Thank you so much, Ms. Li. Those of us who went to Stanford always want to make a trip to see how the wholly owned subsidiaries are doing [laughter].

We have been reading about you in Doonesbury, and one of the things that is a great success story in America is the Asian-American model, in my mind, and tragically, where the Asian-Americans have come in under in a lot of cases severe handicaps, what appears to be the cultural discipline associated with Asian-Americans has allowed in this land of opportunity to go into percentages that have to be the shining light in progress for our young people in the science and technology area.

I think it's very valid all the cartoons that Doonesbury put together. It's very insightful, and I would like to ask you the question, as you were, you know, 30 minutes after you were born, did your mom say, there's my daughter, the brain surgeon or, you know?

How does it happen, and what should we recommend as a Task Force to get what you might call parent accountability and parent discipline and to get what is shown in the Doonesbury cartoons, you know, that we'll now start developing curve busters that are Hispanics and Blacks and Native Americans and women?

MS. LI: I think you're quite right. I mean I come from a culture and a tradition where there is a great deal of emphasis on the sciences and in engineering. I happen to be married to an attorney, for example, who has a fairly successful practice.

And when I indicated to my parents that I wanted to marry him, my mother said, "But how is he going to support you?" [laughter]

MR. OAXACA: That's what I was going to ask.

MS. LI: In this society, of course, attorneys are taken fairly seriously and they [laughter] do do fine work, but in the culture like where my parents came from, which is non-adversarial, lawyers would have a very difficult time making it.

My parents, for instance, really wanted me to go into teaching, because it is a profession which is considered honorable, or if I wanted to be a doctor, that would have also been considered honorable.

I think that we come from a tradition where there is certain types of career paths which are considered either honorable or which are considered credible and so I think [BELL] that when you talk about, you know, the sciences and engineering, it's much easier for people like those of my culture to get into those because there is a type of support by the parents.

And I think it goes back to more than just my parents. It goes back for generations. So, in terms of how you then translate that to other cultures, I think you're talking about something which is probably one or two, two generations down the road.

Certainly my parents' feelings about the sciences and such weren't just of their generation. It was of my grandparents and my great grandparents, and I think that how you translate that to other cultures is probably something much more long term.

And I don't really have an easy answer for you for that.

MR. OAXACA: We in business who deal with lawyers every day--I have to tell you this story that now that we're in the heart of the educational area here in Massachusetts, where there is a tremendous amount of medical research going on, the one I heard was that they are seriously considering using lawyers instead of white mice, and the reason they give is that there are more of them and you don't get as attached. [laughter]

MS. LI: Could I also just say that--just add to that. When I finished my master's at Princeton, my father said, well, why don't you go on for a Ph.D.?--literally just as I finished my master's. And I said, well, I think I've gotten the amount of education that I need. He said, oh, no, one can never be too educated, and why don't you really think about getting that Ph.D.?

So, in my family, just having a master's degree was not enough. And I don't know how you again communicate that type of need or desire to other cultures, and I'm not sure that everyone needs a Ph.D.--and I hope I don't offend members of this Task Force by saying that--but I think we all have to decide for ourselves what is best in terms of making a contribution to society, and I'm not sure that necessarily everyone needs a master's degree or a Ph.D., depending on the fields that you go into.

MR. OAXACA: Any questions from the Task Force? Well, give our warmest thanks to your boss. Tell him it's going to be an exciting convention. And thank you for the warm welcome from the state of Massachusetts.

?: And remember us in his platform.

MR. OAXACA: And we thank you very much for your testimony.

?: Jaime, that was your opportunity [INAUDIBLE].

?: Put the arm on him.

MR. OAXACA: I would like to ask Dr. Sheila Widnall, Professor of Aeronautics and Astronautics of MIT to please join us for her testimony. Welcome so much to the Task Force.

DR. WIDNALL: Thank you very much. I'm very pleased to be here this morning. I see many of my colleagues on the Task Force, and I am delighted that you have come to Massachusetts to meet with us.

If I had prepared a written version of my remarks to you this morning, I would have called it "Beyond Role Models."

Now that's a useful phrase, and if you find that you can make use of it, I give it to you.

What I'm talking about is a stress on making institutions do their job better. I think in an older way of thinking about these problems, the phrase "role models" often came up, and everybody somehow assumed that if we had, quote, "more role models" that all the problems would go away.

I don't think we should encourage a situation in which women students will work only with women faculty. Or where minority graduate students will feel comfortable working only for minority faculty.

I think it's very important that male faculty learn how to provide a supportive environment for women students, and majority faculty provide a supportive environment for minority students.

And where majority students will serve as research assistants to minority faculty, and vice versa.

And I think that that is obviously the ultimate goal that we have.

I believe that women faculty and women administrators and minority faculty and minority administrators can be catalytic, yea, even opportunistic in trying to make their institutions do their job better.

But the fundamental responsibility rests with the institutions, and there is simply no way that we can deal with a problem of this magnitude without working through current institutions.

The written testimony that I will leave with you this morning is my presidential address, as outgoing President of the American Association for the Advancement of Science.

For those of you who are not familiar with this organization, although we have one staff member and one board member here on your Task Force, this is a general scientific organization of about 140,000 members.

We publish the magazine Science, and we are seen as being the voice of the scientific community in interdisciplinary and broad policy areas.

I took the opportunity of delivering the presidential address to comment on the situation for women in graduate school. I felt it was an ideal opportunity to reach the scientific community, most of whom are white and male, and discuss the issues about the environment for women in graduate school and how this might be improved, and in some sense, to put the burden upon them to improve this environment.

You have discussed and no doubt will hear about the demographic changes that are occurring in our society. I think the scientific community may be a little slow to wake up to this, although in fact it's happening all around them.

It's very clear that 10 years from now the composition of our graduate schools, if they retain about the same number of students, will be in fact quite different.

We--the actual absolute number of male Ph.D.s in science has been going down steadily since I guess about 1970. I don't know if anybody has noticed that, but it's true.

We have seen a dramatic rise of women in the professions. Science and engineering have seen a dramatic rise. We have also seen a dramatic rise in law, medicine, and business.

But speaking as an engineer, I am very concerned about women simply leapfrogging over the profession of engineering, having a sense that somehow it is not a receptive profession for women, and going immediately into MBA studies.

Of course, we engineers always think there are far too many lawyers and there are far too many MBAs and if we could just get more engineers, we could get this country on the road again.

Another way of saying it is if we don't meet the women in the laboratory, we are going to meet them in the courts. Of course, that has also happened. The great rise of women in law, including my own daughter, who is likely to become a lawyer.

It's very clear that science and engineering are in need of the talents of the women and minorities who are currently being, as Matina Horner said, deflected.

When she talked about being deflected, the image that came to my mind is the image of a pinball machine, where you drop the ball in at the top and then all of these little levers sort of operate to get the ball pushed out of the main track.

I think that is probably a pretty good image because, in fact, for women and minorities, it doesn't take [INAUDIBLE] slaps before you're convinced that maybe this isn't the thing for you.

I think it's true that institutions will, in fact, have increased enrollments of women in science and engineering, and some of these institutions may bungle this job quite badly, and simply be unable to present the kind of positive environment that encourages women and minorities to achieve all that they are capable of, and really be prepared for what I call the fast track.

I think many leading edge institutions and industries and universities will, in fact, do this job very well, and we want to identify those institutions and figure out ways to reward them and make them more visible.

I think it is generally held in leading edge companies and institutions that an institution that pays attention to the environment for women and minorities in fact improves the human environment for all of its students and all of its employees.

And in fact it is always the white males who benefit the most from an improved institutional climate. Well, we'll take it any way we can get it. I think that that is in fact all to the good.

Again, the emphasis that I want to place on it is that women can be very catalytic in dealing with their institutions, but it is fundamentally the responsibility of the institutions, and I think that's the direction we should push.

Let me say a little bit about the MIT situation, because in many respects it is quite remarkable.

I have been at MIT since I was a freshman. When I came to MIT in 1956, I was, in fact, surprised to find out that there were less than 20 women in the freshman class. It never occurred to me that there could be such a small number of women.

There were no women on the faculty at that time. The situation at MIT has changed, slowly at times, rapidly at other times, until at the present time we have, out of a faculty of about 950, we have about 100 women on the faculty--women broadly distributed across all of the departments, not just at the junior level--major figures in their field, members of the academy, major full professors in all sorts of disciplines, in the sciences, in engineering, in the school of management, and the humanities.

We have deans and we have had chairs of the faculty. We've really had, I think, a quite remarkable record, not to say that we're perfect, and we have a lot of work to do.

Looking back at that situation, I have to say that the way we got there was because of the personal commitment of the top management of the institute, and they were on record as being committed to that, and that is the single most important ingredient in the change of an institution, is the commitment of its top management.

MIT is also an extraordinarily pragmatic place. It is not cerebral. We do not engage in endless discussions about the role of women in some sort of abstract way. We simply go out and we do it, you know, like the Michael Song, "Do It." That's kind of like.

It is a very high pressure place. I won't claim that it is a benign environment for people who feel that they are somehow different than the rest of the culture.

This high pressure place affects all of us, men and women alike. It is probably the case that the women students and the minority students are more traumatized simply by the high pressure of the environment.

But, again, all of us are trying to be opportunistic about ways that we can continually work to improve the environment, and I think it is definitely the case that the women faculty and the minority faculty feel they have the mandate from the institute to suggest changes, to work in a positive way.

And any time we can sort of decide what it is we want to get done, we are invariably successful at getting it done.

I consider MIT to be a leading edge institution. I believe our responsibility is to produce leading edge women and minorities, people who have really had the most superb education that can be obtained, and to launch them on highly productive careers in science and engineering across the country. [BELL]

I would like to close with a comment that--I have a friend who keeps me sane by making profound statements every once in a while. And last Sunday, he made a profound statement that said that the world redefines you every 10 years, in terms of your career and your potential.

What that basically said to me was that about every 10 years a woman needs a new mentor who will help her through that next stage.

I would like to take this opportunity to acknowledge

Ken Hoffman, who is going to follow me on the program. He was in fact my mentor and my confidante during a pretty critical time in my career from about 1968 to 1978, and I would like to say, thank you, Ken. Thank you.

MR. OAXACA: Thank you so much, Dr. Widnall. Questions from the Task--Dr. Clutter.

DR. CLUTTER: Professor Widnall.

DR. WIDNALL: You can call me Sheila.

DR. CLUTTER: Sheila, this is, as you know, a federal Task Force.

DR. WIDNALL: Yes.

DR. CLUTTER: And it is our responsibility to make recommendations to the President of the United States and to the Congress and to the heads of federal agencies about measures that they could take to improve the situation.

If you could make one recommendation, say to the President, about what the federal government could do to improve the situation, what would that recommendation be?

DR. WIDNALL: Can I make two?

SEVERAL MEMBERS: Yes. We'll take two. Feel free.

MR. OAXACA: You don't want to swamp the system.

DR. WIDNALL: Well, I guess I would like to put in two words, and they both begin with C. And the first word is "climate," and the second word is "catalytic."

I think the climate has to be set by top management, and in this case, that's the President. So climate means an obvious and evident commitment, that's real, to these issues.

And I don't think there is any substitute for that. But it has to be real.

The catalytic part is the catalytic opportunistic part that costs money. I think universities respond--well, universities and institutions, but let's concentrate on universities because I think they play such a key role in preparing the scientific personnel.

Universities, in fact, respond to opportunities. I can think of few other institutions that are as opportunistic as universities. What that suggests is that you can have an enormous impact on the present system with just a few little carrots here and there.

Programs designed to foster competition among universities, to succeed in getting certain types of financial support for visiting faculty, for graduate students, stipends of a very special sort for visiting lectureships, for, you know, all the various ways that one can be catalytic in terms of getting universities to compete for really a very small amount of money, but in a situation where they have to put their institutional prestige and commitment on the line in order to share in some opportunities that they see.

So I think those two words--climate and catalytic--are probably the key words.

MR. OAXACA: Dr. Danek.

DR. DANEK: Yes, I would like to follow up on your...

DR. WIDNALL: Where are you?

DR. DANEK: Right here.

DR. WIDNALL: OK.

DR. DANEK: I would like to follow up on your comment about the catalytic activities and ask you for some more specifics. There is a debate that goes on continually with regard to support for activities which in general increase participation in science and engineering or which specifically would be targeted toward women in science and engineering.

With regard to your comment about stipends, lectureships, etc., visiting professorships, would you support special targeted programs focused on women? But would you argue that we should foster the development of many activities which would include women.

DR. WIDNALL: I would be in favor of targeted programs.

DR. DANEK: You would?

DR. WIDNALL: Because I think if left to their own devices, universities simply do not reach out for women in sufficient numbers.

DR. DANEK: How would you counter the argument that then you have a second-class program and that your--the women would say they don't want to apply to a second-class program; they would rather go to a regular program? How would you counter that?

DR. WIDNALL: Well, I wouldn't see it that way. It seems to me that it's simply a new opportunity, and every new opportunity that is presented has a different framework, and I don't think there is any pejorative connotation associated with having a new opportunity.

Let me give you one example of a situation that happened at MIT, and maybe Millie Dresselhaus is in the room and she can comment on it.

Millie, as I understand it, went to Cecil and Ida Green with the suggestion that a special set of fellowships be established for women students, entering women graduate students at MIT.

I think the original sense and perhaps the original argument that Millie might have made is that women often come to a department with a slightly different background than the majority of the students.

For example, a woman with a background in chemistry might want to get graduate training in chemical engineering, and her background might be a little different from the background of the male students, and so therefore, perhaps a special category of fellowships would turn out to be necessary.

The fact of the matter is that these fellowships have turned out to be the most prestigious, mainline, highly sought after fellowships that you can imagine.

The women that get these fellowships have no particular deficiencies in their background. They are absolutely first rate. It simply gives departments another target, another opportunity to get an additional fellowship for their department, based on locating the most highly qualified women applicants they can possibly find.

So, in fact, it is a real plum. It has just no negative connotations at all, and as far as I know, everybody is absolutely delighted with it.

MR. OAXACA: Alan Clive, please.

DR. JENKINS: Mr. Chairman, I think, is that the person you're looking at over on the right, wanted to comment.

DR. DRESSELHAUS: I'm Millie Dresselhaus. I had some contact with the fellowships. Your presentation is exactly accurate, that the original intention was to open the pipeline to get women that otherwise wouldn't come.

As a result of having the fellowships, we have had a catalytic effect, because not only do the fellowship holders come, but they also have other support and they bring on their coattails other people, so that for each fellowship that's granted, we get several very highly qualified women, and these kinds of program that have [INAUDIBLE] effects are very valuable.

MR. OAXACA: Thank you very much. Alan Clive, please.

DR. CLIVE: Here at the Task Force we have yet to get beyond role models. I think that the phrase "role model" is the second most popular one used around here, exceeded only by "How much does lunch cost?" [laughter]

I would like you to speak, if you would, whatever is in your mind and heart on the subject of the tension that women or minority engineers, scientists feel between the desire to get on with their careers and be what they set out to be and the pull on them to be role models.

DR. WIDNALL: It's incredible. I think there is no question that, for those of us--perhaps especially like Millie and myself who passed through the system at a particularly critical time when the numbers of women were increasing quite rapidly--I think what we saw in that was an intellectually satisfying set of professional issues that we wanted to be involved in, as well as in our own profession.

So that there is a pull to be involved in those issues, not totally out of altruism, but because of the opportunity for personal and professional growth that it gives to women in the sciences to reconceptualize their careers and the entire nature of the field.

There is no question that that pull and that tension and the sheer amount of time that it takes to be involved on faculty committees, to be carrying on a set of activities which is entirely parallel and separate from one's professional life, is an incredible drain on one's time and energy.

On the other side, there are certain benefits, in terms of personal growth, a real stretch in terms of broadening one's professional abilities that is a kind of a payment for that.

But one has to say that in terms of traditional career advancement, it probably interferes, because of the sheer amount of time that's involved in it.

MR. OAXACA: One last question. Mr. Norbert Hill, please.

MR. HILL: Could you comment on the unique differences or pressures between minority women and majority women as they try to get through a climate to be achievers.

DR. WIDNALL: I'm not sure I'm much of an expert on that. I'm only assuming that they are intense, that in some sense they are members of both worlds, and so, on the one hand, they are treated as women, and on the other hand, they are treated as minorities, and that they are also treated as women by their minority males.

So that it must be a kind of a double or triple whammy in terms of gaining a sense of self.

It certainly is the case at MIT that the number of minority women on our faculty has been much smaller than the number of majority women. I'm thinking of two, three, four minority women who have passed through out faculty, one of whome I believe is now retired. And I know we have a minority woman in the math department at this time.

But I think the pressures must be intense.

MR. HILL: But I think there is a lot of [INAUDIBLE] in terms of the problems. I think some of the solutions may be different. I'm not sure what they might be.

MR. OAXACA: One very last question, a short one from Dr. Danek.

DR. DANEK: Yes, when we look at the programs that are operated by the federal government to enhance participation of women in science and engineering, we find very few.

Of those that you know, could you cite a few exemplary programs and suggest what else might be done.

DR. WIDNALL: Well, of course, the agency that I'm really most familiar with is NSF. I'm only scarcely aware of what some of the other agencies might be doing, as my focus really is on science and technology in leading edge institutions. I mean that's sort of my focus.

I am aware of the visiting professorships for women at NSF, and I think that this has given women an opportunity to move around to different institutions and to become more visible to both women students in an institution and the male faculty.

I mean there's no question that--I'm sure when a department hires its first woman, it's kind of a traumatic experience, and if they can get some experience with that, maybe the second, third and fourth are seen as much more of a matter of fact.

So I think visiting professorships for women. I'm less familiar with the success of any special targeted research programs. I think NSF should develop a commitment to ensure that women receive research funds in a reasonable proportion to the number of proprosals that they submit.

I have to say that some of the most old fashioned people are people in government agencies, in contracts to universities. They can give you all sorts of reasons why certain things shouldn't be done.

DR. DANEK: Would you like to be more specific? [laughter]

DR. WIDNALL: Probably not. [laughter]

MR. OAXACA: Thank you very much for your testimony. On that note, thank you so much, Dr. Widnall.

Let me introduce now Dr. Kenneth M. Hoffman, who is Professor of Mathematics at MIT, and Head, Office of Governmental and Public Affairs, Joint Policy Board of Mathematics, and the first male who has gotten such a glowing testimonial from the previous speaker. Welcome to our public hearings, Dr. Hoffman.

DR. HOFFMAN: Thank you. I'm very grateful for--to have a few minutes to talk with you. I want to take a slightly different tact.

I should explain a little bit about my own background. I am a mathematician, as you've gathered. I grew up in California, was educated there, and after working in industry for a while, moved to MIT. I joined the faculty of MIT the same year that Sheila entered the institution as a freshman, 32 years ago.

After 15 years in a relatively normal academic career of research and teaching and textbook writing and so on, I then spent a decade in administration at MIT.

One of the things that that did for me is gave me the experience of chairing a commission, which operated for two years, worrying about the future of the institution.

That really got me steeped in the pragmatism of MIT and its sense of responsibility for a variety of social issues, one of which is the one facing this Task Force.

As a result, when I was the head of my department for eight years, I recall doing an accounting job and noting that it took more than 25 percent of my daily time to be concerned with the issues facing this Task Force, for eight years, and that made a deep impression on me, that the problems are formidable and a lot of effort by a lot of people is required to make any headway.

I can say that given the number of old friends that I've made in my 32 years around this town who are in this room today, there is some hope that at least they don't wear us down too easily.

I am not going to go into the what part of what the Task Force faces, the issues. I assume that you are much more deeply aware than I of the full underutilization of talent in the very areas that you are worrying about and that you are fully aware of and will speak to in your report the change perspective on those things that has come about in the last 15 or 20 years, moving from the individual rights, equality of opportunity, underrepresentation mode of thinking into the national imperative mode of thinking, in terms of not making use of the creative abilities of people in these groups.

That adds great power and force to the argument. I assume and believe that you will use that to the utmost when you report.

I'm going to comment in a moment, though, that I hope you gear your recommendations to that kind of national tonality, and a new tone and flavor which is appropriate for a new understanding of the issues.

I also assume that, therefore, that you're going to point out that the issues we face are of such a scale that there will be considerable modification required, and social institutions in the country, not the least of which is education.

In that arena, of course, you know as well as I do what is needed is something that truly means education for all, education which starts very early, is built on a--not just a conviction, but the foreknowledge that everyone can learn, and education that delivers what it takes to help young people learn.

I would say the model is also, start in the early years and concentrate on raising the level of the water table. Do not get preoccupied with supporting the springs that happen to bubble up or thinking that someone is endowed with wisdom to spot at an early age where the springs are going to bubble up.

Raise the level of the water table.

Robert White, the President of the National Academy of Engineering, this fall said, we need education which is a pump not a filter in the pipeline. Now there's an engineer talking.

That's a very different view than removing the stoppages in the pipeline. Transform into a pump.

He was saying that, by the way, at a national conference on calculus, of all things, and he was speaking to the mathematics community of the country: stop being such an obstacle and become a pump.

That's part of the new view. And having stated various assumptions, I want to comment just quickly on two things.

One, I refered to already, the nature of what I think you should recommend in your role, and specifically what the area is in which I think you and efforts of this general kind can probably have the greatest impact in the next two decades.

You can begin the following way--recognize that in the areas of education that contribute directly to success in science and technology, which is in fact most areas of education, there is one in fact that is more fundamental than the others. That's the one I represent.

It also happens to be the area of education in which I believe today we can achieve better the goal of education for all that I was talking about than in most other areas, and I'm going to explain to you why.

It has to do with the fact that it is the area in which there are national initiatives and national leadership mechanisms going that can enable the country as a whole to push in one direction and really make a significant difference over the next couple of decades.

Now, to convince you of these things, I have to calibrate slightly. Mathematics is thought of as an irritating thing in the lives of most people. We all go through it, you know, it's kind of a little thing, right?

All right, let's get scaled. Every day in this country, 25 million youngsters study mathematics in schools of the country, helped by a million teachers.

Three million college students study mathematics, 30,000 faculty.

Mathematics education is a $25 billion a year enterprise, and schools account for well over half of the student contact hours in mathematics, science, and technology--well over half of where your main concern is.

In the colleges, it's 30 percent of education in those areas. It's 10 percent of all instruction in colleges.

Now you are familiar with the fact that in some general sense mathematics is the foundation discipline for science and technology. It plays these critical roles, both relative to opportunity, that is, moving up the educational ladder, and also relative to acting as an obstacle, pushing people out of the pipeline at various points.

By the way, the evidence is that when you get pushed out of the part of the pipeline, you are going to have one hell of a time getting back in.

Remedial mathematics instruction is not successful. I think that mathematics is the fundamental area that you should focus on as an educational subject matter area critically linked to opportunity in these areas, and you should call strong attention to this.

Now there are many people in our society, you see, who might agree with the logic of what I just said, but they will resist it strongly because they feel that emphasizing mathematics is akin to sentencing our youth to 74 years in the salt mines, laboring away in the pursuit of something that someday will get him into an interesting topic.

And certainly most people in this society would think of mathematics as an area not likely to change, an area of education, and to you and to them, it is, fasten your seatbelts.

Mathematics is changing very, very rapidly. It has changed dramatically since the Second World War, growing more than in the previous 7,000 years of its existence.

It is critically, closely linked to this information age that everyone talks about. What do you think the disciplinary intellectual tools are for grouping, analyzing, sorting information, and so on?

That's another way of describing mathematics.

The tools are getting more sophisticated, even as they affect individuals' lives. How many people in this country do you think could understand any reasonable presentation of a risk analysis involving AIDS? They get lost in the second line.

Why? Because we have not succeeded in getting elementary probability and statistics into the school math curriculum, though we have been trying as long as I have been in this business.

The computer everyone talks about is the telescope of mathematics. It has come along superimposed on all this development I have talked about. It is the great instrumentation of mathematics, which has amplified the rate of change of the discipline, and its use in engineering, in industry, in science, and that will increase the effect and impact and increase the need for mathematics in education, not only to get better, but to change in character, and for more people to study more mathematics and learn it at a more basic level.

The computer has done one other major thing. [BELL] It has opened a window for you and for everyone else on mathematics that didn't exist before. You see, this today is the face of mathematics. This is what it looks like to little kids in school today.

It does not look like arithmetic tables as much. It looks like the study, systematically, of patterns in life and the world around you.

I encourage you, finally, to explore in this arena. Learn about an entity called the Mathematical Sciences Education Board at the National Research Council. It is an absolutely unique national leadership mechanism, which holds the promise of moving us off the dime and coordinating a national effort to significantly improve mathematics education over the next two decades.

Great progress has been made in that way, and it will serve as a prototype model for you. Do not recommend to the President and the Congress of the United States that they invest multitudinous monies in a hundred thousand little pots of programs.

Recommend to them that they find the critical point, the leverage point to which to invest resources where they can make a difference. Head Start is a great example of that kind of thing.

But in certain disciplinary areas, and I think mathematics is the prime example, a national leadership mechanism exists which is not federal.

Point out to the President and the Congress there is a distinct difference between "national" and "federal." The federal government is only one small part of the national leadership efforts we need.

You will never muster the know-how in the staff of the federal government to deal with the issues you're talking about. You just won't do it. It's not realistic. But you can muster it other places. Look for the three or four critical leadership areas where things are moving, amplify those, use them as examples, and urge that the resources and the minds and the energies be wagons, in a way, be put behind these kinds of efforts.

Now I cite mathematics as a great example because I have lived through the creation of this mechanism and a lot of other attempts over the years, and really believe it can succeed.

And I remind you that I'm talking about more than half of the education in the general area that you are concerned about. If you can make a real impact there, you can make a huge impact all across the board.

Thank you.

MR. OAXACA: Thank you, Dr. Hoffman. Your submitted testimony has the names of those organizations, I would hope.

DR. HOFFMAN: Oh, yes.

MR. OAXACA: Thank you.

DR. HOFFMAN: And it's the story, Paul Dray, our President, has the favorite story about the little girl whose grandmother gave her a book about penguins for Christmas, and when she got it for Christmas, she wrote a thank you note, said, "Dear Grandmother, Thank you very much for the book. I enjoyed it. It told me more than I wanted to know about penguins." [laughter]

So I will tell you about those [INAUDIBLE].

MR. OAXACA: Dr. Adams.

DR. ADAMS: We have a need to be able to focus, as you have already said, policy kinds of directions. One of the critical areas that we are going to have to deal with is where do we--where do find the teachers for like math and science and physics and chemistry?

And the fact that you can't find them, how do you grow them, how do you develop them? We heard a statistic, for instance, in the state of Michigan last year that they did not certify one physics teacher in the whole state.

DR. HOFFMAN: Yes.

DR. ADAMS: If you had to make some recommendations to us in that area, particularly as it applies to mathematics, the critical kind of math skills that we need to teach calculus and some of the advanced level things in the schools, also at the elementary level, how do you get teachers competent enough to be able to deal with math so that they don't frighten students away that early?

What would you recommend to us?

DR. HOFFMAN: I would recommend, again, the same thing, that you not think that the federal government is going to solve these problems. That is not going to think them through and the Task Force should not try to think them fully through either. They are slightly too cosmic.

And the fact is where you get focused leadership mechanisms going, there are people who understand these things. If you want to know the roles, say, of community-based groups in support of science and math education in the country, you go talk to Shirley Malcom.

You don't try to launch the federal government into a program, you see, of supporting community-based support programs. You--what you've got--we have to learn again that we need national leadership.

It doesn't all have to come from the federal government. The federal government's role may be to support the leadership initiatives which can carry out these things.

In mathematics, the Mathematical Sciences Education Board, within the next year and a half, will recommend a rather massive program of teacher improvement.

But first it wants to tell people what it thinks the priorities are in terms of curriculum instructions on why things need to change and put out a national game plan. That is what this board is going to do--a national game plan for the improvement of mathematics education over the next 20 years.

And it is going to recommend, with no authority--I mean no power, acts with no power, you know--the directions in which people go, and it is structured of a wide variety of types of groups, from the president of the national PTA to classroom teachers to--and learning a lot about how to enlist people in a joint program.

But I would say one other thing, too, about teachers, in mathematics in particular, but also in other areas, the teacher shortage problem, which is almost the worst in elementary school in terms of scientifically, mathematically literate student is going to be greatly alleviated by the computer.

Most people don't know this. If you missed this point, you will miss one of the important things going on.

Modern software, which exists in prototype form for classrooms of the future, delivers a kind of help and support for the teacher in the classroom, which can compensate for a lot of lacks of specific subject matter knowledge.

It's quite startling. It may literally alter the whole dynamics of the teacher supply and demand thing.

MR. OAXACA: Mr. Norbert Hill.

MR. HILL: Perhaps you answered some of the question, I guess we're looking, perhaps, I'd like your comments about the water table. I think you're absolutely right on target there, but we're trying to figure out how to fix a system that maybe can't be fixed.

And if you were going to start over again, what would you do differently, or what would you do, what policies would you implement from the beginning to make sure that we don't get into the mess that we're in at this point.

DR. HOFFMAN: Call the plumber. [laughter]

MR. HILL: Put the water out, uh.

DR. HOFFMAN: Don't try to be the plumber. Don't try to be the one who creates the plumber's--try to figure out where the leverage points are, where the know-how is. This is a country based on know-how. There is a lot of know-how in this country about what to do about these problems.

It simply gets lost in most cases. If you could identify a few critical areas, even one major area--I gave you my favorite example--then you can begin to show people that there are different ways to attack these problems, other than by throwing lots of money out the federal door in a hundred directions.

Education, particularly, as everyone here knows, is impervious to many, many, many local initiatives. Local initiatives in this arena, for example, which do tremendous good for the individuals they are directed toward, have very minor effect on the larger system that's behind it.

But there are ways to move the system, and I will try in my written testimony to lay out what I think is a way to do that without all of us trying to be the plumber.

MR. OAXACA: Thank you so much, Dr. Hoffman, for your testimony. I would like to welcome our co-chair on the Task Force, Dr. Ann Reynolds, who probably had a flight problem, and so we can sympathize with that. It took us a little while longer to get in from Kansas City yesterday. We got in at 11:30 at night, left at 9 in the morning. And that was on the airline that came out number one on schedule. [laughter]

I would like to welcome Dr. Shirley McBay, the Dean of Students of MIT to be our next person to testify. Welcome to the Task Force and thank you for taking the time, Dr. McBay.

DR. McBAY: Thank you very much, and I would like to add a word of welcome, as well, to the Task Force.

I would like to make some comments in three roles. One as Chair of the Committee on Equal Opportunities in Science and Engineering at NSF, another as the Director of a national project on quality education for minorities, and then finally as Dean of Student Affairs at MIT.

My written testimony, which I left outside, focuses primarily on the quality education for minorities project. I have also left there a couple of copies of a report that we issued at MIT in 1986 on the racial climate on the MIT campus.

Let me first talk about the CEOSE, the Committee on Equal Opportunities in Science and Engineering at NSF. I don't think it is a historical distortion to say that CEOSE would view itself as your parent organization, in the sense that, I believe, the idea for the creation of this--of a task force of this sort, came from that committee.

Let me say that, as any parent would say, that we are very pleased with the fact that you are functioning as well as you are. You are not quite what we had in mind, but I would like to begin with a particular recommendation that relates to your existence, and that is that what we had hoped and what we still hope is that one of your recommendations will be to have a government-wide version of CEOSE, and that is, an organization or a structure in which you have subcommittees that would focus on the various agencies--NASA, DOE, DOD, and so forth--as we are concentrating on NSF.

I think it is also fair to say that we do feel that we have been very successful, fairly successful in our dealings with NSF.

I know we all feel very supported by the Director there, as well as by the staff. And I think if we were to try to list, we could name a number of things, areas in which improvements have been made.

There are some continuing issues, and I want to just list three or four specific recommendations that relate to NSF, but I think some of them, at least two of them are generalizable.

First, we have recommended to NSF--these are three that have not been implemented yet, but we are still pushing on them. First, we have recommended to NSF that it commissions a paper on mentoring, the mentoring of minority and women graduate students.

We think that such a paper should be an agenda item for all the various advisory committees at NSF. There are 30 or so of them, and these committees are made up of scientists and engineers from around the country.

So we feel that it would be important for them to hear these, hear the recommendations of such a paper. We also feel that it would be important for those people who receive awards from NSF--and here again, I think from any other agency--to get copies of that paper, so that at least it is saying to the recipients that NSF--or whatever the agency is--views the mentoring of minority and women graduate students as a major priority.

A second recommendation that we have made, and will be emphasizing again, is that NSF re-establish a program that focuses on the disabled in science. There was a program of that nature in the previous science education--previous version of the Science Education Directory.

We feel very strongly that that needs to be reinstituted, or some version of it.

The third recommendation which, I think again, is generalizable, is that we have suggested to NSF that it look at the 10 leading recipients of its funds--and I say that recognizing that my own institution tops that list--but that we, that NSF bring to together the presidents of those organizations to talk about the institutional climate on their respective campuses for minorities and women.

I think--I believe we would find, just as at MIT, that we have strong affirmative action programs in place, very good support services, and that probably there is an awful lot that needs to be done to improve the climate.

We do believe that there is an obligation for those who lead as recipients of government funds to also provide leadership in the areas as they relate to minorities, women, and the disabled.

At our next meeting, I'm sure we are going to make a recommendation regarding the establishment of a formal program on alliances. This has already come up in a previous panel meeting that I attended.

And the alliances that I'm thinking about actually would be modeled on one that exists through a program that is funded by the Department of Energy.

That is one in which there is a collaboration between Jackson State University, the [INAUDIBLE] Dez Foundation in Puerto Rico, and the Lawrence Livermore Laboratories. I think there is a lot to be learned from that, and we would want to suggest that, to NSF that it consider having such alliances with other national laboratories as well as with predominantly minority institutions.

A second form of that formal program on alliances would emphasize relationships between predominantly minority institutions and predominantly white institutions.

As you know, the 80 percent of minority students--Black students in particularly--are on predominantly white campuses, yet the historical Black colleges and universities, for example, all the ones that seem to be very successful in retaining Black students through graduation.

So we feel there is something that the predominantly white institutions can learn from the historically Black colleges, and on the other hand, there are opportunities during the summer for students from these colleges, from the predominantly minority institutions, to do research on the major research university campuses.

And so that is the sort of thing we would be recommending as well.

Now let me shift to the Quality Education for Minorities Project, and my written testimony focuses primarily on that, so I won't spend too much time on it. But let me say that we are six months into a two-year project.

That project is funded by the Carnegie Corporation, and it is based at MIT. We have a satellite center at the University of Texas at Austin, and the reason for that is that Ray Marshall, the former Secretary of Labor, who is a Professor at the LBJ School of Public Affairs, chairs our Action Council, and he has staff there who will be working on some of the issues as well.

The goal of that project is to develop an action plan that will result in quality education for minorities at every point along the educational pipeline.

And, of course, by minorities we mean American Indians, Native Alaskans, Mexican-Americans, mainland and island Puerto Ricans.

This action plan that we will end up with at the end of two years will have specific numerical goals, and those goals, again, are along the pipeline, starting specifically with the number of students who finish high school having studied in a college preparatory curriculum.

And then the obvious goals exist at the bachelor's level, with a special emphasis on math, science, and engineering, and then at the doctoral level as well.

We also intend to pay special attention to minority teachers in science and engineering.

The plan is going to have a series of alternative strategies at each of the educational levels, and we will identify those strategies by a series, through a series of regional meetings and also through a review of existing programs.

There is an awful lot of information that I'm sure you have gathered already about programs that are very successful. Part of the issue is that they are not that visible nationally and another part is that many of them have been operating on shoestring budgets and they don't have evaluation mechanisms in place.

So we intend to learn from what they have been successful at and try to incorporate that into our action plan.

We hope also to come up with some new ideas as well.

There are some critical issues that we are focusing on in that project, and I want to mention four of them to you.

One is we view it very, very important to find a way to educate members of both the majority community and the various minority communities about the importance of education for minorities--quality education for minorities.

That's an enormous problem. We view that as a major challenge, especially we need to concentrate on how we can reach that part of the population that is seriously underserved.

And I am thinking specifically about students and parents who are in urban areas.

A second critical issue has to do with institutional climate, and I think that one of the reasons that that is there is based on the experience that I've mentioned to you earlier about the racial climate on the MIT campus. We think that that is critical that it be [BELL] addressed at predominantly white institutions around the country.

We also plan to focus on minority faculty, because while it is true that role models are not the sole answer, it certainly helps to see someone who looks like you talking about science, math, and engineering. We will focus on that as well.

The fourth area is on public policy, and the reason we think that it is important to emphasize that is that we are not--we recognize that this is a long-term problem, or at least the problem that requires a long-term solution, and so we will be making specific recommendations for public policy.

In developing our plan, we're going to focus on consensus building because we know that nothing that we come up with will work unless we are able to build around the country support for the ideas that we are putting together.

And we will also take ideas and ask people for their ideas from around the country, because again, no one is going to just take something that a group went off somewhere and developed on its own. So we intend to, through the regional meetings and forums, to try to build consensus.

The major question that we will be asking on all of those forms is, who is responsible for the education of minority youth?

And I won't go into that, but if you think about it, there are lots of implications about--and answers to that question.

We will also be establishing task forces. We will be convening minority scholars because we think that they can best tell us how to reproduce themselves, and so we will be talking with them about how to recruit minority faculty, how to develop supportive climates on the various institutional campuses.

We will also be establishing a major data base, where we will have profiles of representative exemplary projects from around the country. We will be--in recognition of the problem that I mentioned earlier, we will be developing some evaluation criteria that can be used to measure success, and also we will be developing methods of evaluation for new initiatives, so that people who are starting out in small efforts will be able to utilize, hopefully, some of the things that we come up with.

Finally, our strategy for implementing this plan, once we get it developed, is through a non-profit foundation, which we hope to raise funds for, that will probably operate out of Washington.

The core effort or activity of that foundation is viewed to be at this point a 12-year demonstration project, where we will not just end up with a report. We feel an obligation to try to demonstrate that what we have come up with actually has a chance of working.

And so what we will do is to try to identify 25 or 30 cities with large minority enrollments at the pre-college level, and work with the superintendents and teachers in those cities, work with community colleges and with neighboring universities and trying to develop partnerships that will enable us to carry out this, the long-term plan.

MR. OAXACA: Thank you very much, Dr. McBay. Questions from the Task Force? Dr. Danek, please.

DR. DANEK: Yes, Dr. McBay, you indicated a number of things that you had made recommendations to NSF, and certainly NSF, I'm sure, is taking those into full consideration. But the question I have is you left out an area of development of special retention programs, nurturing, and you talked about the institutional climate, but did not recommend to NSF the development of special retention programs, which would create stronger academic programs and a more nurturing environment than some of the institutions that you were talking about.

Does that mean that you would put that on a lower priority or?

DR. McBAY: No, it does not mean that. Let me say, because I heard the question earlier about institutional climate, let me say that I think that, based on our experience at MIT that it is clear that one has to have a supportive and hospitable environment.

There has to be some diversity in academic offerings at those institutions. There has to be a commitment, as Sheila indicated, an unambiguous commitment from the top for the kinds of efforts that we are concerned with here.

I think there has to be a strong academic--strong affirmative action program in place. I also think that if you want to get any results, that you really need to have performance criteria include the degree to which one is able to meet the affirmative action goals of the institution.

I think that we ought to reward people who are successful. I don't mean to just--I think you should play up the positive things, and I think that when NSF, for example, meets with the presidents of those institutions that I was talking with you about, but the kinds of issues I'm raising now are ones that could be brought up with those presidents, and then hopefully out of that group, some basic program or idea could be put into--or just a memorandum, it doesn't have to be a program, just something that could be distributed again to all the recipients of NSF funds, talking about institutional climate and emphasizing the kinds of things that are important.

One of the things that we are doing at MIT as a result of that report, but we're doing it for all students, and that is we are trying to encourage informal interaction between faculty and students.

It is--we are having, beginning in the freshman year, an opportunity for freshman to have as advisors faculty members who also offer seminars for them. I think something like that would work as well.

MR. OAXACA: Any other questions? Thank you so much, Dr. McBay, for taking the time to testify.

We would like to take a 10-minute break right now. We will reconvene sharply at 11:25, if we may.

[BREAK]

DR. IVEY: [INAUDIBLE] primarily because of some of the reasons that you have heard here today.

The three programs are the current students, future engineers, summer workshops, our dual degree program in liberal arts and engineering. And I would like to say a bit about the undergraduate science program at Smith College.

And so you can see that I'm taking the focus down out of the graduate school level and trying to move it lower into the junior high-senior high and undergraduate college experience for women.

The current students-future engineers workshop that we run in the summer, we run four teams of people who are invited to come from junior high schools, middle schools, and high schools in New England and eastern New York State.

They may not come from any school unless they are able to get a team, which would consist of a counselor in the school teamed up with either a science or a mathematics teacher from the same school building.

And we are very strict about this. As you may guess, it's harder to get the counselors interested to come to this program than it is to get the teachers.

The unique aspects of our workshop that I would like to point out are that it is a team. We do pay them. We feel that since we try to keep half of our participants being women and half being men, that many of them will have expenses at home around child care while they are away.

So we pay them a minimum stipend, which is $100.

We request action from them. It is not a workshop where you come and you go home and you say, wasn't this fun, I learned a lot.

We do request that they go back home and institute a program in their home town which fosters the goals of our workshop itself, which I will mention in a minute.

We also bring all of the participants in any one year back to Smith the spring following the June that they attend the workshop. And the reason for this is that that is the time that counselors and teachers are advising their young students as to the courses they will be taking the next year, and it is particularly important at that junior high level, which is a time when we know that girls in particular move away from taking the science and math in their curriculum.

We also sponsor this workshop totally out of corporate support. We do occasionally have some foundation support, but primarily we go to the corporations, hopefully in the hometowns of the schools from which the participants come, and we ask corporations to sponsor particular teams.

This is to foster cooperation on the plans that get implemented when these teams go home.

The goals of our workshop are to increase the understanding of the need on the part of teachers and counselors to be pro-active in the advising that they give their girls.

It doesn't work simply to say, how come you're not taking math and science? Or why don't you take it? You have to be much more direct about, you must take it or you're cutting off your options. This kind of message needs to get out.

We also provide information on the technical career opportunities, both in terms of the nature that they are right now and the variety that is available, and that indeed these careers are available to women, even though you may not see very many women in there currently.

The third goal is to help these participants get the nuggets up there, plans for their home district, in place prior to their leaving our campus. So that we have a good chance, since we have no way to insist that they do this. And for most of them, it comes out of their hide as after school activity. So that we feel that any support that we can give them is all to the good.

And that is another unique aspect. We are able to give these teams tremendous support throughout the school year, as they not only plan these programs, but as they implement them in their home communities.

We periodically send them materials and we guage the materials that we send by what time of the year it is and how far along we think they may be in their planning. We ask that they send us in a one-page statement of what it is they intend to do in October, before the year gets going in a way that there is no spending any time on this program unless you have already started.

And then we keep on the phone and on the word processor, giving them a little more help and information all along the line.

When we get calls of distress from people, we have often gone to bat with principals and with superintendents of school districts to see that they get the support that they need from the top in order to pull this off.

I might say that every year we balance the workshop participants from those people who serve primarily minority populations, inner-city populations with those who serve white populations, either rural or city.

And our program has a balance of minority and non-minority people on the panel or speakers' roster.

What are the results of these workshops?

We have been running for five years. We now have about 130 school districts who are running programs. Of the school districts who came the first two years, all but two are still running programs. So now those programs have been in existence for five years.

It is not a one-shot deal. I was terribly worried at first that this would be a one-shot deal. They would run a program for one year, and that would be the end of it.

But I think the fact that we bring them back and we give them another jolt of energy in the spring following the year that they attended the workshop, that we get the impetus going again to keep that program that they have developed going one more year.

And then once they have put that amount of time into it, it appears, if what they tell us is true across the board, that they then put so much time into it, they want to keep doing it.

Cambridge Latin here locally has had a very successful program as a result of a counselor and a teacher attending our workshop.

Some of the districts insist that any of the programs that these teams operate be for both boys and girls, and that's fine, because there are many ways to ensure that the girls understand that they are welcome.

And that's one of the things that we work with these teams to do, is to make sure that the girls are made welcome and that you do get a substantial number of girls attending these programs.

I might say that in this state, the man that runs the competitive math team came to the workshop and told us that he was there because he thought we were passing out misinformation.

He firmly believed that women could not serve on any of these competitive math teams. He stood up the day that he was leaving the workshop and said, with tears in his eyes, I understand why there haven't been any women on the math teams, I've kept them off.

If we do two of those a year, I'm happy, because he affects so many people. And I'm happy to say he's one of our biggest supporters now, and he's done a lot to help other people in this state understand what our workshop is all about.

The success of this workshop has been helped along by some very good national press that we've been able to get out of it, and replication is beginning to happen.

Not that all is well and good. I might mention a couple of problems. We do have space limitations, so it is very small. We can only take 26 to 28 teams every year, but we stay on the campus, even though we don't have much space in June that we can use, because we feel that it is important for these people to be inundated with the fact that women can do science.

We have about 90 to 100 students every summer on campus doing independent research, and we make sure that our participants get involved with that in some way.

Fund raising is also a constant chore, so it is a recommendation that I would like to make, that there be some consideration in your report for emphasizing the need to have other sources of funding than what we currently have.

It takes a lot of time to go out and raise funds for these programs. It would be nice to spend more time on the program and less time on the fund raising.

Second program that I wish [BELL] to talk about is the dual degree program in liberal arts and engineering. It is an undergraduate degree program, as is our undergraduate science program in general at Smith.

The students take their bachelor's degree in one of the sciences at Smith while they are taking engineering undergraduate course at the University of Massachusetts in the School of Engineering.

They then go on for a master's degree, either at U Mass or elsewhere. Most of the students do go on for the master's degree part of the program, although there is the option to major in science and minor in engineering at Smith.

I might say that the success of the undergraduate science programs at the women's colleges ought to be noted. We do produce, by far and away, the largest group per number of graduates of women getting Ph.D.s.

And also it is important to note that the reasons for this probably are that we do have role models. We have 45 percent on the average women faculty at the women's colleges, as opposed to 11 percent women faculty at the coeducational institutions nationally.

Now role models are not the be-all and the end-all, and not every institution is going to be able to have a number of role models.

However, when you can encourage a staff to hire a role model, you find that you do get the impetus there to make your classes, make your laboratories, make your independent research opportunities much more welcoming for either minorities or women, depending on whatever way you are trying to go. It's terribly important.

And I would like to say that I would also like to point out that one of the things that works with women's colleges having 30 percent of their majors in their institutions being science majors, which is very high, is because we expect more of women, I think, and the students respond very positively when you let them know of your high expectations, and I think that this is an important thing that can be done across the board much more easily.

The last thing that I would like to say is that I would like to have some encouragement provided for the replication of all those good programs that you are hearing about.

I think replication can begin immediately. We know what makes for a successful program. We don't know all of the things that make for a successful program, but those things that we do know should be replicated and the money should be provided right away.

We don't have to wait for that, and the corporate world should be encouraged to cooperate with higher education and government in doing so.

MR. OAXACA: Thank you so much, Dr. Ivey. We have three minutes for questions from the Task Force. Shirley.

DR. MALCOM: In keeping with the spirit of Ken Hoffman, I just wanted to point out and asking your comment on this particular point, that the dual degree programs that have basically proliferated around the country out of the goal of pipeline expansion, both in the women's colleges as well as in the minority institutions, hold tremendous potential for expansion of the engineering pool, as well as for addressing some of the problems that we talk about in terms of the narrowness of--concern about the narrowness of the training, the education that's provided to engineers.

And I was wondering, how do your--through the people who come through this program--what is the size?--the number of people who come through this program, and how do they fare in the job market?

DR. IVEY: Oh, tremendous. In the dual degree program--and ours is not a three-two program. It is a four and one or four and two, depending on how you want to look at it.

It has been operating for 10 years. It graduates every year--we have small number statistics, mind you--eight to 12, and in science altogether, if I could lump these two, we graduate about 200 science majors every year.

And I can speak for physics majors and engineering majors at Smith College. I have never known one in the 19 years I've been there not to have a minimum of three to four job opportunities. They have all gone on to graduate school at very prestigious graduate schools, if they wish to do so at that time.

MR. OAXACA: Any other questions? Thank you so much--oh.

DR. ADAMS: I was just going to [INAUDIBLE] one comment that would add to what you just said. You might want to know that one of the new professors at U Mass is a person who went through Smith College in that program and [INAUDIBLE] to MIT and got her BS and master's and just finished her Ph.D. at Stanford.

Her name is Dr. Avra Demond. She is an American Indian, went through a program such as that. She is also a GEM student, which is [INAUDIBLE]

MR. OAXACA: Thank you so much, Dr. Ivey. Let me recognize the wonderful work that the folks are doing for the hearing impaired. I might ask the folks that are working on the hearing impaired, are there people right now that need that service? If not, then maybe you could sit down and take a little break. You make the judgment.

I would like to ask Dr. Millie Dresselhaus, Professor at MIT as our next person to testify. Welcome to the Task Force and thank you so much for taking the time to come by and testify.

DR. DRESSELHAUS: I'm very happy, delighted to have been asked to speak about the more general aspects of careers, not only the preparation for careers, which has been most of the testimony, as I understand in the various cities that this Task Force has gone.

We have heard in ample measure the great strides that have been made in the educational programs, pre-college to some degree, today, and also locally at MIT in the actual college programs, undergraduate and graduate level.

I think we've shown an existence there of that in the last 20 years at MIT, starting from a very small number of 4 percent of the undergraduate population.

We have gone to 40 percent women. That's quite an extraordinary achievement, and not only are they there in numbers, but in quality. Their performance is indistinguishable in most cases, and in other cases better than that of the average student.

However, I think the national statistics tell us that we have made significant gains, but further gains are going to be more difficult to achieve, and part of the reason is what I am going to talk about today. It's roadblocks on this whole pipeline of careers.

It's not only the entry point. If we don't have the people entering the field, there's nothing further to talk about. But if there are obstacles further upstream, it will impede the flow at the lower points, and I think Betty Vetter is the one who has provided us with ample statistics that the pipeline is slowing now at the undergraduate level, and largely because of perceptions of roadblocks ahead.

Since there hasn't been much testimony given anywhere on this subject, I was told to give a little bit of background, not only my ideas of what might be done.

What are the roadblocks?

It is true that there has been considerable progress in the last 20 years, maybe more than that. More women have entered the careers, they are better trained, they are getting advanced more rapidly than at any previous time.

Women are becoming more acceptable in the work force. However, there is not equality. We are a long ways from that.

There are two kinds of barriers, and that's what I'm going to address, I was asked to address today. I focus the comments around two rubrics.

One are intrinsic barriers and the other one is extrinsic barriers.

Within the category of intrinsic barriers, women, as they enter the professions, after they have completed their undergraduate or graduate degree, have very difficult choices.

Women at this point are in their early 20s or mid-20s. Many of them, right at the entry point to their careers, must make a decision whether marriage or no marriage, whether marriage with children, with few children, or with a full complement of children.

And that choice, various choices greatly affects what happens thereafter.

The next topic is the dual career family. Whereas today, many men are affected by this. With women professionals, it's almost all of them that are affected by this. The division of responsibility in the home is seldom equal.

There are real constraints on available time, constraints on available energy. That is, when the woman appears at the job, she has already worked half a day, and it is not always easy for her to have the same peace of mind as somebody who has had nothing to do until the day is started.

There are geographical constraints and various other things.

Women have to make a whole series of compromises, and the compromises they make are seldom satisfactory, either to career or personal choices.

That is, the family, to some degree, gets short shrift and the career gets short shrift, and women feel guilty. They feel conflict, they feel pressures, and this exacerbates the problems of the whole situation.

It starts in the 20s and it is a cumulative effect that goes on and on pretty much until the children are reared, and then there is a little bit more peace of mind.

But by that time, your career is pretty much set, and you don't have that much choice in changing things.

So that there are real intrinsic barriers that we have to contend with. I will come later to some suggestions about what could be done, because it isn't a zero set. There are things that could be done.

There are socialization conflicts, and these are real. Probably Matina Horner was addressing these. I'm sorry, I came on the red eye from California and I was unable to attend to hear what she had to say.

Women tend to have lower confidence levels. When the competition for advancement in the more prestigious jobs becomes acute, it's difficult with the socialization that we train women to have, to be able to contend with the cutthroat competition that goes on, especially in industry, in the--in moving ahead through the advancement ladder.

This is less true in academia in this sense.

Women often say to me that they can't be themselves, that they lose their identity of what they thought that they were, their own personal image of themselves, as they try to compete and make it in the business world or the world of science, the world of engineering.

Men and women have different priorities. They seem to have different priorities, and as they execute their jobs, they do different things.

For example, I've noticed amongst our faculty, the women faculty tend to be much more involved with service type of things. They do more for the institution. But they do less, in a way, for themselves. There are fewer women faculty that have their own businesses on the side, which is very common for men faculty.

Women always say--often say--that the pressures on them are greater than on the men, and I think that this is probably true. They feel a greater demand on their time.

This starts not in the career. This starts in school. I think with our undergraduates we already begin to see this. We see it more with our graduate students. We've recently had a survey of women graduate students at MIT, and that was one of the main conclusions of the survey that impressed me, is the greater stress that our women students, who were performing at an equal level and producing at an equal level and prepared at an equal level, they feel more under stress and they work longer hours to do seemingly the same things.

They find the deadlines more threatening. Travel in connection with jobs--jobs in science and engineering usually demand some travel. And for women in their 20s and 30s this is often a major problem, and it impedes progress through their careers.

Women are impressed with their invisibility. That is, they are often in the work place the only one in the group. If they screw it up, if they goof up, the attention is on them. They feel that is a major pressure.

As you go further and further up the ladder of advancement, the pressures on you to succeed are greater. I have heard this said from many women at high positions.

And after a while, they reach the point, in their late 30s or 40s, and they say, I have had enough of this. I would like to be myself, and they start something totally different that's less demanding, and they leave the--what we have built them up to do, contribute to the world of science and technology.

As we get more and more women into the professions, these, some of these pressures are easing, and they stick more and they are able to cope with these pressures.

I would say that the pressures on women is not only children and husband, but it is also parents. That is, when the parents become aged--we see this with our women faculty--they have to deal with people at all levels, and it is quite a significant pressure.

Let's cover the extrinsic barriers. They are real also. A manager in industry is normally unfamiliar with women professionals, because he has probably never employed one before. And if he has a critical assignment to make, he is going to make it to somebody who is familiar to him, and that's a man.

So there are barriers that arise, through no maliciousness. That happened just in the normal course of events because there are too few women that have done it before. We need the existence theorem.

Women need track records before they are given the opportunity to show what they can do, and therefore, it is so important for women to have impeccable creditionals and that's what we have been hearing from the previous testimony, because that's necessary to get ahead.

Managers fear risk, and women represent greater risk than men for almost all kinds of employment. There are some of the obvious risks--risks of pregnancy, relocation of family, pressures outside the job, socialization, travel restrictions.

I could go on and on. There were many such.

And, of course, other intrinsic barriers are outright prejudice in hiring and giving proper job assignments and allocation of resources, promotions.

Women complain that they are left out of the decision making loops. When something is about to happen, there is some opportunity. It's the white males that know about it, and the others are left out of the pipeline.

So, as a result of this, there are some outcomes that we can expect, and that is, in fact, what happens.

To do a given job, women have to be more qualified and for the various reasons that I have given, that is the way it has been and that is the way it will be for some time to come.

Women have to make personnel choices, and these often conflict with the optimization of their careers. This is the real world and I think we have to live within the real world.

If we are talking about 25 percent of the work force in science and engineering to be women, and we say that they are not going to have families, that is also a great loss to the nation, because these are people who are, in some ways, the best qualified to contribute to parenthood.

So we have to develop some kind of a system that allows both careers and raising of families.

Constructive actions--let me conclude with that.

There are a whole series of constructive actions that can be--actions and interventions that could be taken and could have some impact.

As Sheila said and others have said also, the commitment of top, top management is probably the key, the most important factor of all, and maybe this is the commitment of the President, the commitment of the nation, commitment of all of us, that if we are going to progress as a country, we need all talented citizens, and that includes women, minorities, and everybody. We all have to contribute to the best of our ability.

And as more of the unrepresented groups enter the work force, it becomes increasingly doable for the next groups to contribute at an optimal level.

Networking at the workplace, through the professions, and regionally are mechanisms that have worked and have had a positive impact. More of this could be done.

Role models were mentioned, and whereas it's true for young students and it's true at the undergraduate and true at the graduate level, it is also true in the professions.

We need equal opportunity programs. I think people agree that fairness is something that this country is all about. But there is always a question, what's fair and what's equal.

And some support at the federal level on defining what equality is and what fairness is would be a useful input.

We need mechanisms to provide input to management of various organizations and operations to develop this commitment, and in doing so, to develop concern to address the special needs of women employees.

This doesn't mean that it will be extra costs, but it means different requirements and different considerations.

Some such might be flexible benefits packages. In the workplace, we always have benefits packages, and these in women and men are not necessarily identical.

We have a great need nationwide of quality child care, quality and affordable child care.

One solution that is quite popular in this area, and I don't know if this has been brought to your attention, is the women-owned businesses, and in this very last issue of the Mass high-tech paper that we all get in the mail in this area, Route 128 newspaper.

They had a listing on one of the pages of 55 women-owned CEO operations. And I looked through the list and many women, friends of mine, who have their own businesses, were not on the list. So out here on Route 28 we've got more than 55, because I know of more than that.

And this is a new direction. I think it's a great direction. Women find it often easier to combine all their prerequisites of family, profession, and all that by doing it themselves, and starting their own companies.

In this way, they are able to optimize some of their own socialization factors which are a handicap in the large organization to the advantage in the small organization, things like care, patience with people, attention to detail, reliability, interest in customer satisfaction, and so forth.

The women-made businesses around here are doing very well. They are small-level things. But this is one way that we can contribute in a unique way nationwide.

I wanted to comment in closing about--to Ken Hoffman, is he not longer here? I wanted to say this, that with regard to contributing to science teachers, there is a great national need and we have the resources, they are right there. They are the students that graduate with bachelor's degrees in mathematics, in physics, in chemistry, and whatever.

And these people go on to graduate study in their own disciplines. If there were a national education fellowship program that took such top people and giving them the same kind of fellowships that they get when they go into their disciplines, giving it to them in the education field would give you a totally new avenue to attract top talent pool into the teaching professions.

Right now, those people, after four years at MIT, cannot afford a teaching credential. They can afford to go on for a master's degree or a Ph.D. because that is sort of free of charge, you know. The fellowships pay for it.

But if you want an education credential, you have to pay out of your own pocket. So we're missing at a very important opportunity, and I wanted to comment on Hoffman's idea. I don't know if anybody has mentioned it at your previous hearings.

MR. OAXACA: Thank you very much, Dr. Dresselhaus. One of the things that I've noticed in industry, along with all the other things you mentioned about women, is the very insidious approach by men as they view women as competitors and how they are able to very subtly kill them early in their fast track by even such things as having their wives throw so-called dirt into the gas tank, as they go, have to travel on business trips together.

If you address the problem for Hispanic women, having been married to one for 31 years, you know, you ask the issue, you know, what's the complement?

Ann Reynolds says, what's the full complement of children? Statistically, it is four times what everybody else has in the United States these days.

And so, it becomes an even greater cultural issue for Hispanic women, as I view it. So these things are very subtle, and you see them every day. Even today, you see that sort of thing, and if you don't have managers that are going to look beyond that, that is a real roadblock.

We have a very short time for questions. Yes, Dr. Reynolds.

DR. REYNOLDS: Thirty years ago, when I was here on this campus, there was a superb master's degree program in teaching, just for the kind of people you describe. Is that still here, President Horner?

DR. HORNER: The MAT program?

DR. REYNOLDS: Yes.

DR. HORNER: That's undergraduate. No, it went away for a while, but there is a new re-entry incentive program for undergraduates, in conjunction with the school of education.

DR. REYNOLDS: To get that year or year and a half capstone in order to...

DR. HORNER: To do it in conjunction with the AB degree.

DR. REYNOLDS: Yeah, good. Thank you.

DR. DRESSELHAUS: Is that fellowship program paid for?

DR. HORNER: They don't have to pay for it. It's part of their current undergraduate [INAUDIBLE].

?: That doesn't address my point at all.

MR. OAXACA: Dr. Shirley Malcom.

DR. MALCOM: I want to--Professor Dresselhaus, because of your involvement in science policy, in the science policy area, I wanted to point out that in science policy, it's easy to still be the only, and how are we going to--would you make any comment about recommendations regarding science policy and the formation of committees by the various agencies here, because right now we have a lot of committees that are still made up of all old white men.

I was struck by this yesterday when I--I mean last week, when I went to San Diego to participate in a panel that was dealing with science policy issues. And we had one day with the panel and the next day with people reacting to what the panel had said, and that was a panel of all old white men.

And it seems that they are the ones who are...

MR. OAXACA: Would you define old. [laughter]

DR. MALCOM: Older than you. [laughter] And in the particular setting, I was the only woman, the only minority, and the only person under 55.

And it seems that if that's going to be the group that has to be addressed, to whom the recommendations are going to have to be addressed, and the only who are actually going to do something about what we're talking about, that maybe we should have some recommendations to the actual composition of that community.

DR. DRESSELHAUS: Well, more women have to be put on these various committees, and that means that the people that set up the committees have to have a commitment that this is important.

I think that many of us who have served nationwide on committees have made input beyond the average to the various deliberations.

So, well the truth of the matter is, that we get asked to contribute to so many of them. But at MIT we have a large number now of tenured women faculty who could serve on science and engineering national committees, and quite a few of them have quite a bit of experience.

But--and this is other schools as well--I'm just talking about my own institution, where I know who the individuals are and what they can do.

But two things are needed. One is the identification of the committees and their needs, and the second is the identification of the people to meet those needs. And I think that both are available and it's just a will to make it happen and be pulled together.

MR. OAXACA: Thank you so much, Dr. Millie Dresselhaus, for your testimony.

I would like to invite a young Hispanic Ph.D., Dr. Gilbert Lopez--I don't know if you folks have seen the movie, "Stand and Deliver"--I think Eddie [INAUDIBLE], the detective in "Miami Vice" and the original star of the movie, "Zoot Suit," which was not the image that you would want Hispanics to portray, since I come from El Paso and that particular gang that was portrayed there lived on my block.

But here is a gentleman, along with one of his colleagues in California, Jaime Escalante, which has done wonders in the area of mathematics and science, and we welcome you, Dr. Lopez, for taking the time here, and we're anxious to hear about your Hollywood contract and what you're doing in science and technology.

DR. LOPEZ: First of all, I have to say that I'm from New York City and I don't know anything about gangs. [laughter]

MR. OAXACA: They're all clubs--I saw "Saturday Night Live."

DR. LOPEZ: And very social, too. I would like to pick up on Kenneth Hoffman this morning, in a way. I have prepared something that was going to be more general.

However, I would like to really start off by making some recommendations to the commission.

The first recommendation is that, although we have this pipeline, which is the root of most of the problems, that there are some logic restrictions in it that might appear at different points along that pipeline, and I'm recommending that in fact that the commission look strongly at supporting mathematics programs at the eighth and ninth grade level. And I will enlarge on why those recommendations are being made.

The second is that, in fact, that also I would like to recommend that the commission think very carefully about promoting the completion of four years of mathematics for all students in the country, including the pre-calculus.

MR. OAXACA: Amen.

DR. LOPEZ: And three, that universities can play a very important role in this by offering calculus courses for credit for those students who in fact complete the mathematics, including the pre-calculus, by the junior year. So that, in fact, they would offer college courses in the calculus or in discrete mathematics for those students who in fact had completed the pre-college mathematics.

And then fourthly, getting back to "Stand and Deliver," I think that we could do well right now. In fact, I have had some discussions with the NSF just in the recent days, taking a movie like "Stand and Deliver," get a fine editor to cut that down to about 20 minutes and make it available to every high school in this country, and in fact to teachers.

It is a marvelous, inspirational movie, and in fact by being at that 20-minute level, I think you can get a lot of mileage out of that.

Let me just speak a little bit about the recommendations in terms of pipeline. The eighth and ninth grade I see as very, very crucial, and our work in New York City would suggest that, for the most part, although there is a, certainly a need to develop a pipeline K through 12 or even before that, that if we want to get some results in a short period of time--and I speak of this as an engineer--that we have to try to do something to demonstrate that kids can learn.

And I think that if anything that Mr. Escalante has done out there in California certainly has demonstrated that in a fairly short period of time he has gotten young people to perform miraculously.

And in our work in New York City, we seem to indicate the same kind of remarkable growth when students are really given the foundation and the academic support to build strong foundations that they need to achieve well in the courses that we want them to achieve in.

And to a certain extent, it is as simple as that. Young people have just a remarkable facility to learn, and we have to kind of acknowledge that learning is not linear at all.

As it turns out, it is somewhat fortunate in the sense that the work we have been doing in New York City and are now doing in Atlanta, or Fulton County, Georgia--under a grant from the National Science Foundation--would indicate that, for the most part, students can, in fact, in the third and fourth grade [INAUDIBLE] complete four years of mathematics by the 12th grade.

In other words, you can take a student who, in fact, has not had adequate instruction, who, in fact, may not have had a sequence of learning which in fact allows that student to build a foundation, and in a period of a half a year and a year provide the foundation.

Now what that suggests is that the process of selection that we have had going on in this country for the last hundred years may not, in fact, be the one which is going to allow us to progress in the way that we would like to.

To give you some examples, I think that--again, I speak from personal experience, and I'm not so sure you can generalize this--but if in fact you are going to build a product that you want to sell, then you have to build that product in consonance with some sort of marketing program.

By suggesting that we require that all students complete four years of mathematics, we are actually suggesting that in fact we alter the supply-demand, which in fact restricts the learning of mathematics for a lot of students in high school.

There simply just are not enough mathematics teachers in high school. And in fact, it has always been that way.

This country never really wanted more than about 5 or 10 percent of the students in the educational system to get the kind of mathematics needed to pursue science and engineering, and there we have it.

By requiring four years of mathematics, including the pre-calculus, you [INAUDIBLE] generate the kind of interest and, I think, support to create the mathematics teachers to let this happen.

By getting the universities involved, and I think the universities play a very key role here, because at least in our work in New York City and Fulton County, what we have, especially in schools which have predominant Black and Hispanic populations is a lack of a critical mass.

And frankly, when you undergo any kind of a project, unless you have a critical mass of resources or people who have the energies or the talent to make it go, it falls upon a leader to try to make the program go by inspiration.

And generally speaking, you need really more than that.

So you need a critical mass of teachers in a school, and at least in New York City, we do have the critical mass of teachers. What we don't have is the critical mass of students.

And that is where the whole notion of both academic preparation and what I call academic encouragement comes from. So the student has to realize that there is kind of a payoff or an incentive here.

And what we have found in New York City, that just simply getting a student to go to a college to study the very same courses that he would study in high school is an incentive.

And we have remarkable progress by young people who simply study in a college setting taught by high school teachers, surrounded by several college students who work with them to make sure that they build a foundation and the confidence to continue.

And I look at mathematics basically as a process in which you have to concentrate a lot. You have to be consistent in what you do, and you have to have a lot of perseverance.

And a lot of young people who have come up through school systems don't really have the resources to allow them to get that kind of confidence, and my own feeling there is no greater role model than another student, who is just a little bit older than the student, who in fact is successful.

That student sees that other student as a person that they can be. And so you have a situation where, although the problem is sometime put in terms of being almost intractable, we don't see it that way.

We see that, in fact, there is a lot of encouragement out there, and what we have to do is to get away from this whole notion that only some students can learn mathematics.

And I really look at mathematics as the key here, because frankly without the mathematics, the kids are not going to take the science. Without the mathematics, they are not going to get the--what I call that abstract, generalizable kind of thinking which allows them to look at things in a kind of a different light.

The other thing is that the mathematics in itself is more curious than other academic disciplines that they might study in high school, in the sense that it is abstract. I look at that as being its greatest strength, and I frown a little bit on applications being given to mathematics before students have an opportunity to develop that strong abstraction that allows them to generalize things.

And then, secondly, it has really very little cultural ties. So that, in fact, the student is really learning a subject that doesn't come from any one place, or in one period in the history of civilization.

So it--again, the recommendations that I made are basically ones which are directed at mathematics as being the key to enlarging that pool, and that whatever we do has to concentrate at the eighth and ninth grade level, because it's that point in time where, in fact, kids will have the opportunity to finish their high school program with the four years of mathematics that they need to pursue college study in science and engineering.

I'll leave it at that.

MR. OAXACA: Thank you very much, Dr. Lopez. Are there any questions by the Task Force? [BELL]

Your program is surely to be commended. It is a very tough uphill battle as we try to fill up the pipeline. We surely would like to reserve a right to bug you for all sorts of data as we--we are going to be coming out with our first interim report here shortly, but the Task Force goes on until 1989, and we will learn from that as to how we implement.

And we thank you again for taking the time to come by...

MS. WINKLER: Mr. Chairman, can I...

MR. OAXACA: Oh, there's a, there's Ms. Winkler.

MS. WINKLER: One of the most difficult things that we have to deal with in terms of curriculum, which I think is a very key area that you've raised is the role of federalism.

Federal government, at least in the Department of Education, is pretty well explicitly by law forbidden from getting involved in curriculum issues at the elementary and secondary level.

At most, we can sort of dance around the edges--research and so forth.

That implies to me--I don't see that changing anytime in the near future. Can you give us a sense of how we could get from here to there in terms of the eighth and ninth grades, as you mentioned, given that limitation as far as the federal government is concerned?

DR. LOPEZ: The work we are doing in New York City addresses that problem actually. What we have learned in New York is that, basically in inner-city schools there is not much math learned, K through eight, formally.

But there is sufficient amount of math learned so that in fact you can use what students bring to the school, put together a curriculum that starts at ground zero.

So, in essence, what you have, at least in some of the schools that we're working with, is a program in which all of the kids are selected at random, or in fact we have kids coming into the school and all of them are taking the same transitional program.

In effect, what we are doing is starting at ground zero, and starting at ground zero implies that, in fact, somehow you have to provide much more time and much more opportunity for those students to develop foundations.

And through some creative administrative processes, you can use, in fact, Chapter I money to give those kids additional time, both at school and on Saturdays.

In fact, we have Saturday morning programs where in fact there is probably better attendance on Saturday than there is during the school week.

And basically, it's the student knowing that when he makes a decision, or she makes a decision, to go to school on their own, and that's what they are doing--the student is making the decision to go on their own--that they find this environment in which they can concentrate on one subject solely, and they have the support--academic support--both in college students, or high school student, or in teachers, so that when they leave four or five hours later, that in fact they have learned a great deal of mathematics that they may not have learned during the week.

And that is fundable, by the way, by federal grant, by federal monies.

MR. OAXACA: Thank you very much., Dr. Lopez. Uh, we're going to fit in four testimonies from the floor. You are allowed three minutes. We don't have time for question and answers, so I would like to ask Ms. Joanne Sherwood of Layton, Middlesex Community College to please testify. It's three minute testimony, please.

MS. SHERWOOD: Thank you. My name is Joanne Sherwood and this is my colleague, Kathleen Hall. We have collaborated on a program called, "Anxiety-Free Mathematics," which we call the "Path to Math."

Now this course has been designed for those who wish to pursue mathematics, but are either reluctant or unable because of their anxieties or because of previous negative experiences.

We have endeavored to deal with the multiple causes of math anxiety and also to teach techniques of relaxation and reprogramming.

Coming from separate disciplines, Kathleen from mathematics and I from stress management, we pooled our ideas and resources and came up with an eight-hour program and also a workbook.

The workbook allows those who cannot participate in the classes or in the workshops to test themselves at home, or to work in small groups of their own.

We see the causes of math anxiety as falling into four major categories:

One, lack of understanding of the real number system,

Two, negative classroom experiences,

Three, undetected learning disabilities, and

Four, societal conditioning.

We addressed each of these categories in the following ways. We begin with the development of the real numbers with respect to operations. The schematic diagram of this development is presented and discussed.

The result of the procedure is that students are prepared to define each computation in terms of a number set and an operation.

Self-assessment follows, and students are asked to take a 10-minute arithmetic quiz, correct that quiz, and then evaluate their own work.

The self-evaluation tool, we have called "Rate Yourself."

And then using a chart and a scoring system, the students identify categories of errors. Two sessions later, after some training in relaxation techniques, the students then take a second test, which we have entitled, "Relax and Test Yourself."

After that second test, the students are instructed to reprogram any errors in basic addition and multiplication facts which they have detected.

The reprogramming of skills is discussed in terms of learning modalities.

The issue of negative classroom experience is addressed in two ways--by discussion and by the use of the "Math Anxiety Test," which is a tool that we have developed specifically for this particular model.

The issue of undetected learning disabilities is discussed as a break from the normal learning pattern, and emphasis is put on self knowledge, finding one's optimum learning mode, and then developing a personal learning style.

Societal conditions are addressed under two aspects--psychological, in terms of attitudes, and physiological, with respect to male and female development, and also in terms of right and left brain dominance.

Through our program, we have been able to effect change in both attitudinal levels and skill levels, and at the conclusion of our program, the students are prepared to choose their point of entry into a sequential mathematics program.

We hope they are preparing then to enter the technological society of the 1990s.

Thank you very much.

MR. OAXACA: Thank you very much. We are very anxious for your written testimony. I think this mike is no--I guess it is working now.

I would like to ask Dr. Christine Jones, who is

Harvard-Smithsonian Center for Astrophysics, who will express her views. Welcome, Dr. Jones. Thank you for your time, and you got three minutes.

MS. JONES: The importance of role models and mentors for encouraging participation by underrepresented groups is widely accepted. Although it is natural to look for these role models among our teachers, in my field of astrophysics, the very small percentage of women and minorities in the university faculty limits the effectiveness of this source.

For example, there was a recent survey done of the five top academic institutions in astrophysics, and they have a total of 98 astrophysics faculty members, only two of which are women.

Although women have long accounted for about 10 percent of the astronomy Ph.D.s, they remain underrepresented on the faculties of academic institutions. Thus it is probably unreasonable to depend exclusively on this very small number of women to serve effectively as role models.

While increasing women on the faculties is certainly desirable, fortunately there are other sources of women astrophysicists currently available to serve as role models, and these sources can be effective.

Let me cite one example from my own personal experience. Between 1974 and 1981, in our division at the Center for Astrophysics, my husband and I had responsibility for hiring, supervising, and working with individuals employed as, quote, "data aides," who helped in the analyzing and reduction of X-ray satellite observations.

This was a relatively small group, ranging from two to 12 people at any time, comprising about 25 individuals total. we encouraged several to pursue careers in astrophysics.

The results have been gratifying. In fact, between 1974 and 1981, we sent as many women on to graduate school in astronomy and astrophysics as did Harvard University.

In this regard, it is fair to note that although we also helped several men to enter graduate school, Harvard did send a greater number of men. [laughter]

I recently received the following proposal to referee from one of the women who we had sent on, and at the end of the proposal, she cited this following statement, "I can only add that I appreciate the objectives of this program, having experienced firsthand how important female role models can be for young women early in their careers.

"I was an undergraduate at Cal Tech in the mid-seventies, just after they began accepting women undergraduates. I never had women as professor or TA in any science course. I recall knowing only one female post-doc and one female graduate student in astronomy or physics.

"I left Cal Tech feeling I would, 'never make it in astronomy.' In retrospect, I think the lack of role models and the low expectations my professors had for me had a lot to do with it now.

"After graduation, instead of going to graduate school, I took at job at the Harvard-Smithsonian Center for Astrophysics, which has a large number of women at all levels--graduate students, post-docs, etc.

"My direct supervisor was Christine Jones. She influenced my career directly through her concern and encouragement and indirectly through her example by combining a fine scientific career and a full family life.

"Although I can see the status of women in astronomy is much higher now than in the early seventies, there obviously is a great deal of need for improvement."

I would just like to end by saying that I would like to make two primary recommendations to this hearing.

The first is that on the national level we continue to make a commitment and a stronger commitment to fund basic science research and science education.

And the second is that you identify where women scientists are employed and work with them to replicate the programs that have been successful--the summer research programs, the assistantships programs--and you replicate these at their institutions, where they can serve as the supervisors and role models.

Thanks very much.

MR. OAXACA: Thank you very much for your testimony. I would like to ask Andrea Shlipalz, who is a senior at

Harvard-Radcliffe, for her three-minute testimony.

Welcome to our Task Force.

MS. SHLIPALZ: Thank you very much. I have a different perspective than most of the people who have...

MR. OAXACA: Just remember, you are the future. We are leaving you a perfect world, don't screw it up.

MS. SHLIPALZ: I'll remember that. I am an anthropology major who did my senior thesis on studying seniors in physics and engineering at Harvard-Radcliffe.

This university has some of the topmost students in the country, that are very talented and have the potential to go on to become leaders in science and technology.

Unfortunately, 50 percent of them drop out as freshman.

Why is that? What discourages students, both men and women, from staying in science?

Instead of doing a quantitative study, I did a qualitative study by interviewing, you know, in-depth interviews, talking to each student for an hour, hour and a half, finding out what the reasons were behind their experiences in science.

And the students I interviewed had been in the departments for four years.

The main things I discovered is that every student I interviewed considers him or herself the atypical science student. None of them consider themselves a normal science student, which is unfortunate because they all have a lot in common.

Many of them are involved in other activities. They are not what is stereotypically geeky or grindy students.

So this is one idea that really should be emphasized, that students in science need to be, communicate with each other, that they have a lot of other interests, and they do not need to separate themselves from other science students to fit into the normal college environment.

Because Harvard is a liberal arts institution, science students that I interviewed do not feel comfortable talking about science with other students in departments.

For example, most of the women, especially in physics and engineering, do not tell anyone that they are in physics or engineering. So instead of, you know, sharing their knowledge of science and sharing their ideas with fellow students, they tend to keep it to themselves and end up alienating themselves, not only from other science students, but from other Harvard students.

The problem I have really noticed in doing--I did an anthropoligical study--language was very important. Men and women use different terms in discussing the tensions they feel.

For example, women really focus on friendship, support groups, study groups. Men do not verbalize these problems. They also realize that they do not study with other people or that they do not fit into the science department, but they did not communicate that to me.

Another is the difference of support groups, such as peer groups. Instead of just looking at role models as older, you know, professors, faculty members, it's very important for younger students, freshmen, coming into institutions, to identify with older students who have been through four years or a couple of years, and can help them prepare for what's ahead, so they understand they are not alone.

I had an article today in the Crimson, yesterday in the Crimson, just talking about it's important to be sensitive to science students, for other students outside of science to be aware of these issues.

The problem is, I realized, just in my studying this for the past year, I know more than most science students know about the problems in science and technology.

This is something that the media can help, teachers can help, advisors are very important in making students aware that there are problems. They are not the only ones that feel isolated.

And I agree with Dr. Widnall that the institutions should do their jobs better. In looking at physics and engineering as cultural systems, I realize that what they state as their goals, as far as having good advisors [BELL] are not in actuality--they do not actually do.

Advisors only meet with the students to sign study cards. They really do not interact with them enough. Faculty members, the same thing. They should focus, not as much--they should combine their interest in research with also teaching these students, who will--it's true--be leading the country in the generations to come.

Thank you very much.

MR. OAXACA: Thank you very much, and we are very interested in your written testimony. Thank you again, and there's hope for the future.

I would like to ask, as our last person to testify in the morning session, Ms. Marybeth Ruskie, who is a professor, associate for women in mathematics at Wellesley College. Welcome to the Task Force and thank you for your time.

MS. RUSKIE: Thank you, I will try to be brief. Actually, I'm a Professor--can you hear me without the microphone? OK, I'll use it--Professor of mathematics at the University of Lowell, but I am representing the Association for Women in Mathematics today, which is based at Wellesley College.

Due to the time constraints, I have singled out a particular issue to talk about. I don't think it's--I know it's not the only issue of concern to women mathematicians, and I'm not even sure that it's the most important one.

We have selected it primarily because it is an issue of concern that people representing the funding agencies here are in a position to do something about.

Let me begin with a few statistics. Nearly 10 percent of the Ph.D. mathematicians teaching at four-year colleges and universities today are women.

Twenty percent of the Ph.D.s in mathematics granted to U.S. citizens every year since 1983 have been to women.

Thirteen percent of the membership of the American Mathematical Society, which is a research society, are women. This is quite a bit in contrast to the public perception that there are no or few women mathematicians.

The numbers are certainly not as large as one would like, but they do indicate a substantial number of women mathematicians currently active in research.

One reason that the public perception has not changed as much as it ought to is because the mathematics community has not included women as invited speakers in conferences. This has been quite noticeable during the past year, when we have witnessed program announcements for several major mathematics conferences, which did not include a single woman speaker.

In particular, a symposium in honor of Henry Vial, held in May of 1987; the symposium in honor of John Von Neuman, in June, scheduled for June of 1988; and a symposium on America Mathematics in Its Second Century, held in conjunction with the AAAS meeting in Boston in February.

In addition, the centenniel meeting of the American Mathematical Society, scheduled for August of 1988, will have only a single woman speaker on its program.

The gains that women have made in recent years, both in terms of increasing their number and their research contributions, will not have the kind of impact that they ought, if these gains and achievements continue to be ignored by the mathematics community and establishment.

The absence of women from these mathematics programs is particularly detrimental, I think, to graduate women at the beginning of their research careers. It does not encourage them to pursue research careers seriously when they see no women at conferences they attend, or on the posters for these conferences that are posted on the walls.

In the case of the AAAS meeting, the failure to include any women speakers was particularly egregious because this program was clearly intended to present mathematics research to the news media and to the public. [BELL]

To not include a single woman speaker in such a public event is inexcusable--can I have one more minute?

There is change. The meetings of the American Mathematical Society have included a significant number of our speakers in recent years. That is primarily because they have a policy of placing women on the program committees for these conferences.

In the conference I mentioned above, with no women speakers, there are also no women on the program committees.

This is an issue--all of these conferences also receive funding from NSF or other federal agencies. This is an issue you can do something about. You can insure that there are women on the program committees, that when they are reviewed, the reviewers address the issue of whether or not qualified women have been invited to speak, and you can send them to women to review. Thank you.

MR. OAXACA: Thank you so much. We hold our head up high in this commission, if you noticed, the testimony this morning, we only had two token males. And we thank you for your testimony.

We will reconvene at 1:30 for the afternoon session. Thank you again for testifying and thank you again for giving us your time and your wisdom.

[LUNCH]

MR. OAXACA: We would like to welcome Dr. Raymond Kurzweil, Chairman, Kurzweil Computer Products, on the application of artificial intelligence, and because the good doctor has been good enough to put together a very comprehensive presentation, we are going to violate all rules and give him the full 20 minutes.

Welcome and thank you for taking the time to put together this presentation.

DR. KURZWEIL: Thank you. It is a pleasure to be here. I would like to talk about what I perceive to be some of the principal barriers to handicapped persons playing an active role, both in their education and in particular, their vocation, and with a particular focus on science and engineering careers.

I have worked with many handicapped people over the last 15 years--in particular, have many close professional and personal relationships with a number of visually disabled persons.

I work closely with Larry Scadden, who is here with us, for many years, and he has, in fact, made major contributions to the--to some of the projects that I'll talk about.

The year I was born, 1948, Norbert Weiner wrote a book that has become a classic, called, Cybernetics, and in that book, he postulates a vision that someday we will have machines that can automatically translate information from one modality to another, and this would overcome the principal handicaps associated with disabilities in vision and hearing loss, and describes a vision where you could take auditory information, like I'm presenting right now, and turn that into a visual form, so that deaf people could understand what I am saying right now, without a human translator.

And he postulates a similar vision for visual information, such as the world of print.

Now, it would be about four decades--three or four decades before Weiner's vision was translated into reality. Part of the reason for that is that it is not possible to simply take information in one modality, such as print, and present it to another human sense without intelligent translation of it.

And there have, in fact, been attempts to do that. You can take prints and translate it into an auditory signal simply by having, let's say, different frequencies, different pitches, represent different areas of black or white.

And you can translate, let's say, print like this into a little melody, which would represent the shapes of the letters, and presumably a blind person could use his or her intelligence to translate that.

Similarly, print has been translated into a tactile form, where you an actually feel what the letters feel like.

It turns out that each of our human senses is designed to accept information in a very different way. Our visual sense is organized differently than our auditory sense, and information presented to those senses needs to be specifically designed for the strength and type of intelligence that each of our human senses requires.

So these attempts to do straightforward literal translation of one modality to another really doesn't work, in terms of providing a rapid replacement of these particular senses.

What is really needed is a machine that can intelligently understand the information and then retranslate it into a form that is optimal for that particular channel.

For example, and a machine that we will actually demonstrate for you today, if you take the world of print and have the machine actually understand what the letters are, group them into words, figure out the pronunciation of each word using several thousand pronunciation rules, and then present it as human speech, a blind person can read at the same speed as a human reader--as a sighted reader.

And this actually overcomes a principal handicap associated with visual disability. I think the number of blind people who have joined us here, and in some cases from different parts of the country, is testiment to the fact that blind people do not have travel limitations.

We have had, since our inception, a number of blind employees who travel all over the country and the world, represent us in many different forums, and perform any tasks that I could ask a sighted person to perform.

Really, the only principal handicap that a blind person has had has been difficulty in accessing the world of print, and braille and talking books, while valuable, don't fully replace that.

Only three or four percent of the books printed each year are made available by the Library of Congress in braille form.

A blind person really needs access to an interoffice memo or a school publication, topical literature, not to mention books and research materials, immediately without waiting for several months for that to get translated into another form, or having to depend on a sighted reader.

Let me demonstrate to you this particular technology, and then talk about how the same concept can apply to other disabilities, such as the hearing impaired, and also physically disabled people.

I would like to present to you Bernice Boyd, who is the Vice President of the Reading Machine Program at Kurzweil Computer Products.

Bernice, if you will just explain briefly what this machine is and give us a quick demonstration of it.

MS. BOYD: I am very happy to have this opportunity. What I have here is a portable, hand-held scanner which reads ordinary books and typewritten material. It is connected to a little keyboard [computer talks], as well as to a desktop scanner, which allows you to read automatically.

I am going to let you hear how it sounds.

SCANNER: Good afternoon, Co-Chairpersons [INAUDIBLE] welcome, and members of the Task Force. It is a pleasure to be here with you this afternoon. In just a few minutes [INAUDIBLE] will introduce Mr. Raymond C. Kurzweil, who created me. First, though, we thought you might enjoy meeting me. I am the Kurzweil Personal Reader and came here today to show you how leading edge technology can enable blind [INAUDIBLE] learning disabled individuals to learn and work in a world dominated by printed material.

I weigh only 18 pounds and I'm very portable, which makes me especially attractive to scientists, engineers, and others whose professional or personal interests require research, participation in conferences, reading, reviewing files or papers, and document processing.

I represent you as a research application of artificial intelligence and intelligent character recognition. I can be used as an interactive work station in combination with any IBM compatible PC and have powerful data input and output capabilities.

I can also work with [INAUDIBLE] system. I can read virtually any typeset or typewritten material, including single sheets, bound documents, and newspaper.

I can read columns [INAUDIBLE] I have six different voices and am now learning to read French, Spanish, German, Italian, and [INAUDIBLE]

I am accurate, fast and reliable, and can be used with an earphone for privacy.

Now that you have learned a little about me, let me introduce my friend, Mr. Ray Kurzweil, founder and Chairman of Kurzweil Computer Products, Kurzweil Applied Intelligence, and Kurzweil Music Systems, Incorporated.

Mr. Kurzweil also chairs the Kurzweil Foundation. About 12 years ago, he developed my predecessor, the Kurzweil Reading Machine, which was the world's first consumer product using artificial intelligence technology.

Today, Mr. Kurzweil will share brief remarks about the importance of improving access to innovative technology for the handicapped, and will comment briefly on the need to increase opportunity for young people, as well as women, minorities, and the handicapped to pursue careers in science and technology.

DR. KURZWEIL: Let me make just one personal comment about this particular model. It has some important personal significance for me.

We first introduced the Kurzweil Reading Machine in 1976, and it was quite a cumbersome device in comparison. It cost $50,000. It was quite large. It read a limited number of fonts.

You would not be able to understand the voice at first listening. A blind person would have to spend some time getting used to it.

We made a commitment that--that real objective and long-range goal of the program was to develop a machine that would have a handle on it and that you could carry around, that would be relatively portable and affordable by individuals, that would be understandable without any getting used to, would read virtually any printed material from magazines to books to newspapers and so on.

And I am personally proud and gratified that with the help of many brilliant individuals in Kurzweil Computer Products, we have been able to accomplish that goal now in 1988.

We are also working in another one of my companies, Kurzweil Applied Intelligence, on the opposite problem, which is turning speech into printed form, or into a display.

We have already applied that to the physically disabled, people who are hands impaired, who are unable to use their hands, and therefore cannot use computers, keyboards. They can't type, they can't handwrite, they can't use equipment in general.

And we have provided speech recognition technology that enables a hands-impaired person, which could be someone with cerebral palsy or any one of the 200,000 quadriplegics in the United States.

There are a number of neurological impairments that prevent use of one's hands, that allows these individuals to use computers and word processors and other equipment to create written documents, to interact with computers, and to control their environment.

One such individual is able to actually hold down a programming job and programs all day long by talking to his computer. There are many individuals who are able to write written documents actually by talking to their machine.

This device has up to 10,000-word vocabularies and the vocabulary adapts to each individual's own working vocabulary. And, in fact, I write a lot of my own personal correspondence by talking to our voice activated word processor.

A longer-range goal that we're working on, and feel that will be feasible within the next five or six years is to apply that technology to the deaf, where a deaf person could, for example, in this meeting, be looking at a little display and get a constant real time readout of all the transactions that are happening here.

I think the public in general is not aware of how severe a difficulty hearing impairment can be, in terms of accessing discussions like we're having now, and obviously there is nothing unusual about this discussion.

For science and engineering careers, personal interchange that's verbal is a vital part of communication and working.

In fact, there are many human factor studies that indicate the ability to solve problems verbally is vital to doing any type of professional work.

This is actually a problem that blind people do not have. As I have mentioned, blind people, using modern mobility training, can travel with ease, and obviously have no problem in engaging fully in a discussion like this one.

But this type of technology would overcome, I think, the principal handicap associated with the disability of hearing loss by allowing them the ability to understand human speech.

In general--let me make one final concluding remark, and then I will be delighted to take your questions. There is a very fortunate and perhaps coincidental matching of the strengths of artificial intelligence technology today and the needs of the handicapped.

A handicapped person is an intelligent person who has, like everyone else, a high level of human intelligence to apply to problems and the interchange of information, but is missing some narrow skill or ability, like the ability to see or to hear.

Artificial intelligence technology today and the threshold that we're on is not able to provide far-ranging cybernetic geniuses. What we are able to provide in our intelligent computers is the ability to perform narrow intellectual functions, like the ability to read. That requires intelligence, something that we consider to be an intelligent function.

There are machines that can do medical diagnoses, that can find hidden energy deposits, that can make financial judgments, that can do a wide variety of pattern recognition tasks.

We can program cruise missles with the knowledge of terrain and they can find their way around using intelligent pattern recognition techniques.

These machines are not able to engage in wide-ranging intellectual discourse. They are able to perform narrow intellectual functions.

And very often that ability is well-matched to the narrow losses of a handicapped person. I think, really, the main disability, handicap that a blind person has is the inability to access print [BELL], and a technology like this can overcome that principal handicap.

And I think the primary role of the government would be to A) make knowledge of this information--information about this type of technology widely accessible so that handicapped people are aware that solutions to these problems exist, and then encourage the dissemination of this type of equipment to those people who could benefit from them.

Thank you. I would be happy to take any of your questions.

MR. OAXACA: Thank you very much. I am delighted to see that somebody can finally pronounce my name and it's a machine. Questions? Yes, Ms. Winkler?

MS. WINKLER: Could you tell us a little bit about the money side, and how much do these things cost now? And can you talk about where you were able to get the funding for developing this technology?

DR. KURZWEIL: OK, the development has been funded as private enterprises. The--this particular equipment will be less than half the price of its predecessor. Its predecessor was $20,000.

Moreover, there is a long-term, low-interest loan fund which will provide both a discount from the purchase price and a four-year, low-interest loan that will enable individuals to access this technology within the budget constraints of a working professional.

The speech recognition technology is in a similar $5-$10,000 price range, and we are very fortunate that this technology is primarily solid state electronics. The price performance of solid state electronics improves by double every 18 to 24 months. So the cost of this technology comes down by half every year and a half or so.

And I actually did a little analysis. We have kept ahead of that general industry trend, in terms of our ability to bring down the cost of our technology.

So, ultimately it will come down even further.

MR. OAXACA: Shirley Malcom.

DR. MALCOM: How many of the reading machines are in use now and in what kinds of places?

MS. BOYD: There are approximately 1,000 reading machines that are in use today. These--this one that you see here has not yet been put into use. We haven't yet announced it. So you're seeing a preview.

They are mainly in libraries and other public institutions, agencies. A few individuals have machines of their own, such as Stevie Wonder, and a few other fortunate blind individuals.

We expect that this will be available to a lot more people at this lower price.

MR. OAXACA: Have you done any studies that you might present to the Task Force on what it might cost the system to do the adequate job to get our young people that are disabled, starting with the K through 12, and into the school system, so that you have a higher yield of disabled that go into science and technology, which is one of the basic issues we are trying to address?

Have you done studies of that type, that kind of lays out in a pro forma way what investments might be required by our nation?

DR. KURZWEIL: We haven't formally studied that. There has been a national consensus to mainstream handicapped persons wherever feasible. This type of technology is in general a very cost-effective way of realizing that, in that it provides equal access for that disabled person to information that their non-disabled peers would have.

One of the challenges in mainstreaming is if you put a handicapped child alongside non-handicapped peers, as opposed to an environment where they are with people that have a similar disability, they have a challenge to keep up.

In school--I mean if we take a blind person as an example, they are not going to have any problem engaging in the classroom debate, but they will have problems reading.

So this type of technology is essential to that, and it has been our goal as a company to make it as affordable as possible. We are committed to continuing to apply the ongoing semiconductor advances to more and more affordable equipment.

And as it continues to come down in price, it will enable that process to continue.

MR. OAXACA: Ms. Bishop, please.

MS. BISHOP: Yes, just one question. Can your machine read numbers?

DR. KURZWEIL: Yes--in fact, it will...

MS. BISHOP: We heard words, but I was wondering about numbers in terms of math or chemical equations, etc.

DR. KURZWEIL: Yes, it will do that. In fact, it will articulate the numbers intelligently, like 1968 or 19.45.

It has a number of other features, like a built-in calculator, an ability to interface to personal computers, so that you can read information off the screen, and also allow a blind person to enter printed documents into their own personal data base.

We are also adding an online dictionary, so they can get a definition of words on command.

MR. OAXACA: Dr. Alan Clive, please.

DR. CLIVE: Thank you.

MR. OAXACA: I called him Mr. earlier and he got all upset, and so I publicly I'm calling him Dr.

DR. CLIVE: Well, in return for the correct pronunciation of your name--as a matter of fact, that's one of the things I wanted to--I have a semi-facetious and then a very serious question, because I was interested in how you did get the machine to pronounce Jaime's name correctly, which my Deck Talk absolutely slaughters?

And the second question is readers have vacations, and readers have family crises, and they have classes to study for, and all kinds of things that result in their not being there when they are needed.

Now, none of that applies to the reading machine, which is one of the reasons why it would be so sought after. But readers get sick and machines get sick, too, and I'm wondering if over the past 10 years, you have got any sense-- you can tell us anything about the reliability of this technology.

How long will it go before it has to be fixed?

DR. KURZWEIL: That is something that has been a key goal of our development efforts, and early machines were not very reliable. And the machines in recent years have been extremely reliable.

This particular unit, I would say probably half the development went into specifically life testing all of the subsystems to provide a very long what we call mean time between failure.

Inherently, this type of technology is very reliable and should go for a long time between servicing [INAUDIBLE] for us to provide service when it is needed.

But you did touch on a very important issue, which is if a handicapped person is dependent on other people to perform a vital function thta you need to do every hour--read print, type on a keyboard, and so on, that's an enormous limitation to that person being able to compete.

Independence is really the key objective of technology like this, and obviously that goal of independence is supported by the technology being as small as possible, so that you don't have to just go to one place to use it, being as inexpensive as possible, and as you pointed out, as reliable as possible.

MR. OAXACA: Larry.

DR. SCADDEN: Over the last several months we've had a tremendous number of witnesses talking about minorities and women. Very few talking about disability. So I really would like you to address one specific question in relationship to your, oh, about 12 years of experience in disseminating a piece of technology for disabled people.

Are there scientists or engineers or other technologists who are disabled--in this case, blind--using this technology in their professions today?

MS. BOYD: Yes, the answer is yes. I can think of the one man who comes to mind, I think may be familiar to you. I don't think he would mind my mentioning his name, Ted Barber, who is a blind physicist in New Mexico.

And I can tell you that during the last blizzard here, Ted Barber got me to open up Kurzweil Computer Products so I could show him this latest reading machine, so that he could get the first one he could, as soon as we announced its availability.

And there are quite a few others who are using this equipment in their science careers. I know Ted has been able to read physics books, and in the early days, it was--took a lot of his own intelligence to figure out what the physics formulas using Greek letters translated into.

But it was reliable enough and predictable enough that he was able to understand it.

DR. KURZWEIL: Also, the speech recognition technology of Kurzweil Applied Intelligence has been used by a number of different people for computer programming.

MR. OAXACA: You know, that gentleman you mentioned testified before our Task Force in Albuquerque.

I would think that the Task Force would be very interested in, if you folks have any kind of data, because part of the recommendation has to be what the capital investments have to be in technology as learning tools.

And since we're addressing the issue of pipeline, and we're trying desperately to address not wasting resources that are available as the makeup of our communities. That it would go a long ways to help us in an area that admittedly we have not had testimony either of the intensity or the level that you get on women and minorities.

Anything that you can submit to this Task Force would be very welcome in the area that we have discussed, because I think this is an area that has been neglected and has gotten surely quite a bit less attention, in my experience.

DR. KURZWEIL: We would be happy to follow up with an analysis of that, and I agree, the problems of disabled people are special in a way. In one way, they are not special, in that a major problem of disabled people is one of public misunderstanding, and of the community at large not being aware of how capable handicapped people are, of how they are able to overcome their disabilities in the same way we all overcome one limitation or another.

The value of this type of technology is to really, not only to help overcome those limitations, but make it evident to the whole population that these barriers are surmountable.

We would be happy to follow up.

MR. OAXACA: Thank you. Dr. Shirley Malcom.

DR. MALCOM: I just have one last question, and that is, I am interested in how, in whether--since this is close to April 15th, I'm interested in whether there, how this is funded, whether--how is this handled with regard to the tax codes, for example?

Is is supported for rehab funding or exactly, does somebody have to come out of their pocket, and what are the tax implications in terms of write-offs?

DR. KURZWEIL: OK, it's a complex situation. We have taken some steps to provide on assistance, I mentioned this multimillion dollar loan fund, which will make it a lot easier for individuals to afford.

There are a lot of programs, on both the national and state level, and innumerable private foundations that provide assistance of one form or another, but it is a very fragmented system.

And it is, in fact, very difficult for handicapped people to navigate through that system and to know where the assistance is, and there's even cases where assistance lies unutilized because people who could use it are unaware of it.

I think one of the needs is to provide effective means for handicapped people to know where the assistance is, provide some coordination of the programs so that they would be more effectively utilized, including the thousands of private foundations that try to provide assistance.

As a manufacturer that is trying to sell equipment, we find people that very much want to have it, and try to put them in touch with funding sources, and we have a lot of professional expertise to apply to this problem. We know how confusing a system it is.

So quite aside from providing more funds, which of course is always a need, just providing guidance on where the funds are, what the programs are, would be a tremendous help.

MR. OAXACA: Thank you, both of you, for your testimony and for the work that you are doing.

I would like to ask Mr. Robert Sondheim, the Supervisor of Planning, Massachusetts Rehabilitation Commission, to be our next person to testify. [pause]

Thank you for taking the time to be here with us today, Mr. Sondheim.

MR. BARTELS: I would like to introduce myself. I am Elmer Bartels. I am--Bob Sondheim is sitting with me. I am Commissioner of Rehabilitation in Massachusetts, and Bob had arranged to be here, and I wanted to come with him and take the lead in the presentation, and Bob certainly is available to help in terms of the testimony or on some of the work he has done in his lead role in rehab technology within the Rehabilitation Commission here in Massachusetts, if you don't mind, Mr. Chairman.

MR. OAXACA: Welcome to the Task Force.

MR. BARTELS: Thank you. I come here today, I think, to provide a few perspectives, kind of my own personal perspective, in the sense of a career that has been oriented around the use of technology, for myself as a person who is a quadriplegic.

I come as the Director of the State Vocational Rehabilitation Agency, and we have some history in using technology for helping people with disabilities get to work.

And I have some observations in terms of the future in some of the items that we ought to be looking at together, with regard to making rehabilitation technology available to all people with disabilities, whether that is related to work or living independently as productive citizens.

As I look at my own personal history, I can see what has happened in the past that has brought us to today, which kind of leads into the future, and certainly the presentation by my predecessor here at the table gave us a good look at today, and also a glimpse at what's coming down the pike in terms of the future.

To give you a little story of my own personal past, technology is really what has provide me with the opportunity to develop a career.

In 1960, I broke my neck playing hockey and I was a senior in college, and became obviously a quadriplegic with limited functional ability in terms of my physical use of things and being able to manipulate my environment.

After a year in a hospital environment, I returned to college and finished with a bachelor's degree in physics, and went on for two more years at Tufts University and got a master of science degree in nuclear physics. That was in 1964.

Now what was important along the way was that I learned how to program a computer in Fortran. Then, any of you who have been around long enough in the computer field, in the early 1960s, we had things called an IBM 1620. It was about the size of this table. It had an operating system that you had to feed into it on cards. It was a deck about eight inches thick, and then on the end of that you put your Fortran program, which was "Fortran and Forego" at the time, as they called it.

And you would feed your program in and in about 20 minutes or an hour later, you would get your output on cards, and you would walk over to a computer, if you could walk, or to a printer, and you would put your card deck in and it would print out the information that the computer had calculated for you.

The limitation in this particular computer was 16K in memory. It's kind of interesting that as you look at a personal computer today--I just had my Apple upgraded in my own office--I now have over half a million bytes of storage. I have a hard disk. I have a keyboard that is accessible to me.

I have a screen that I can see what is available in the computer in terms of output, and I have a printer that can print out anything and everything, plus a lot of function, in terms of the software that is available in that, in terms of spreadsheet, data base, word processing.

And what took an hour on the 1620 can now be done in a matter of milliseconds and have a result.

Based upon my learning Fortran when I was at Tufts University, my first job was at MIT and there I used my knowledge of physics and my knowledge of computing and put them together and was a systems analyst and nuclear physicist in the sense that I was writing modeling programs for nuclear physics problem and high energy scattering, and doing that down the road, down Mass Avenue from Harvard.

I kind of started off my career, then, as a programmer. After working for about four years as a programmer at MIT, I became enamored with the computer, and particularly computer-assisted instruction, based upon some of the work that Seymour Pappard has done in computer-assisted instruction, and again making the computer a viable tool in an educational setting.

I went off to Honeywell with the idea that I would be working on developing computer systems. There I had access to more computer power and in fact, terminals that were tied into Honeywell equipment, and built a computer-assisted instruction system, though it never saw the light of day in terms of marketing, it at least gave me an opportunity to see what CAI could do for people with physical limitations, in terms of learning, as well as people with learning disabilities who could benefit from the repetition that could be provided in a non-hostile environment, in terms of, if one is incorrect, the computer can really come back and restate the question and try again without someone being yelled at, for instance, for being wrong.

The computer is very non-threatening in that way, if it is deemed that way by the user.

At Honeywell I developed my career to the point of being department manager in terms of computer software development in a number of complex areas in software emulation, language translators, file translators, what have you.

Now why do I tell you that particular story?

I think for me it's one that technology is what made my career possible, based upon the fact that I started out as a nuclear physicist, worked in the computer field, used my analytical skills, and developed my management skills to become a middle level manager in an engineering environment at Honeywell.

Where did that take me personally?

Well, I now will kind of flip over to be Commissioner of Rehabilitation, which is what I am today and have been for 11 years.

I would not have that opportunity had I not had the opportunity of working my way up in the engineering environment, based upon the technological tools that were available at the time.

As Commissioner of Rehabilitation, I think there are a number of things that we look at in terms of serving people with disabilities, to help people get to work.

Under the Rehabilitation Act of 1973 and its amendments, we see that the State Vocational Rehabilitation Program is, in fact, a work program. It helps people with disabilities get to work through vocational assessment, vocational guidance, purchase of services and things, which includes computers and some of the equipment that Ray Kurzweil showed you today, so that people can be productive in a work environment.

And we serve all types of people and within the Rehab Commission, except for the blind that are served by a separate state agency for the blind.

So it is a work-oriented program, where competitive work is our value to help people become financially independent through work.

Over the last 10 years, we have bought a lot of computer equipment for the clients that we serve and we are just kicking off within our agency an assessment to go back and look at what goodness did we do with the computer equipment that we purchased.

How did we meet people's vocational needs? What could we have done better? And what cost implications are there? And what equipment is available today that is of lesser cost than we bought in times past?

And again, as Ray pointed out, the cost of equipment is coming down rather quickly. But also there is some stuff that is off the shelf that very often has not been used where it might have been that is also less expensive. [BELL]

One of our particular needs as a rehabilitation agency has been to get good assessments of the technological needs of people with disabilities to be productive in the workplace, and also to provide improved managing and manipulating of their environment, whether that be in their living situation at home or in their work situation at work.

We have a few resources here in Massachusetts that I think have served us quite well. Children's Hospital Medical Center has an assessment capability and does develop some very high-tech equipment for our clients.

Tufts University has a Rehabilitation Engineering Center that is funded under the National Institute of Disability Research.

On the North Shore, we have an organization called CAST, C-A-S-T, and they are doing work in their area of the use of PC for learning purposes and also to give people, primarily kids, with disabilities access to a computing environment.

And we also are very interested in the use of the computer as a non-vocal communicator for people with CP, for example, who are, in fact, non-vocal.

Another project area we have been working in, and Bob Sondheim, to my left, has been kind of leading that for us within the Commission, is to do an assessment on how technology could be used in a home-based setting, where an individual could work at home, be tied to a computer environment, wherever that might be, whether it is in Boston or Nome, Alaska, it doesn't much matter, in terms of use of lease lines or dial up systems, where an indivdual can do productive work from home, like processing inventory, or to do invoices or to do word processing or calculations, what have you.

And we do have some experience within the Commission, though at this point it's not very well documented. That's one of the things that we hope to do in our evaluation.

Another particular project that we started about a year and a half ago was, to help people with disabilities who have a basic knowledge area, based upon a high school degree, or preferably, a college degree, where they have had trouble getting into the job market, is to by teaching them the use of Lotus software and the Symphony product that is data base, word processing, and spread sheet, where we give people the extra edge by knowing that particular set of software, they can be much more valuable to the hiring employer, and therefore get them over the hump from unemployment into employment.

The Lotus Company here in Boston has been very supportive of that project, and in fact, is providing the software free. They have helped us to purchase the computers that are used in the training.

We at the rehabilitation agency are paying for the trainer to teach people with disabilities in that program.

We also have a good deal of experience in sending our clients to school in Massachusetts to become computer programmers, and there are a number of people who have become computer programmers and developed their career around that, just as I had the opportunity to do so.

I think those are some of our demonstrated interests within the Rehabilitation Commission, and we are looking at doing more.

There is a new environment that we are in, I think, based upon the Rehabilitation Act amendments of 1986, there is a new requirement under the Rehabilitation Act the clients of the rehabilitation agency be provided with an assessment, in terms of their use and the utility of rehabilitation engineering techniques to help one to achieve a vocational goal, and that we have the authority in law, in terms of the listed services to purchase such equipment.

Now we didn't need the Rehabilitation Act Amendments of 1986 to tell us that we ought to be in the rehabilitation engineering environment, but we find that the Act Amendments did, in fact, endorse that for all to see, and that we can all try to live up to that on a national basis.

We also find that employers are finding expanded modes for working with people with disabilities. Now I have been in enough work sites in industry to see instances where people who are high-level quads, like at Sipacan [PHONETIC], which is a company down in Marion, in southeastern Massachusetts, that has a high-level quad who is working on end stage quality control using a configuration of a personal computer and related equipment that was set up by the employer at their own initiative, and have an individual working almost full time, gainfully employed, competitively paid, to do the work.

I was also, had the opportunity to be down at Instrong [PHONETIC], which is a company in Canton, and they, too, are hiring young people with disabilities to use personal computers in some instances in the packaging of software and getting it ready to go out.

So, there are instances of success we can point to, and fortunately, I don't think we know all of them. There are many out there that we could not catalog for you today, though we hope to over the coming months.

We also see changing expectations. The fact that this Task Force has been put together and endorsed by the Congress to do so indicates that the Congress has changing expectations and the Congress changes their expectations based upon the interests of their constituents.

So we certainly are very pleased to see that.

We also see that there are more severely disabled people in our society today, and that being the case, there are opportunities for technology to help us to provide meaningful solutions towards productive independence, as well as independent living independence.

Now what are some of the questions on the table for us, in terms of bringing rehab technology to the people that need it. We all recognize that there are limited dollars in the various programs that are presently authorized by the Congress for the purpose of purchasing rehabilitation technology for people that need it--not to say that there are limited dollars overall necessarily, but there are limited dollars focused on the issue of rehab technology.

We need to develop funding options. I think the vocational rehabilitation program is one of them, but I do not think that we can look at the present rehab programming and the funding that we have available to us under the Rehabilitation Act, to be the sole and only opportunity for making rehab technology available for people.

There was also an independent living section of the Rehabilitation Act called Title VII, which if it were fully funded would be another opportunity for us to buy rehab technology to help people with disabilities live independently, and control their environment through computer-related equipment.

We have the rehabilitation engineering centers around this country that are funded through the Rehabilitation Act, and they have in many instances been the developer of technology and ideas, in terms of communication devices, which was done here in Boston by the Tufts University Rehab Engineering Center, and others who can help develop the technology and begin to do pilot projects on specific individuals and their needs.

I think participating employers have done a lot, and will continue to do a lot. One thought we might put into place is just as private sector employers have a $35,000 a year tax credit to make their companies wheelchair accessible, we might also expand that so that they could make deductions based upon making their workplace technology accessible for people with disabilities, and that is something I might recommend for you in terms of your report to the Congress.

Certainly computer manufacturers have a large role to play in making their basic equipment accessible to people with disabilities.

Honeywell Corporation did a project on that within the last year and developed a manual on accessibility features of primarily the personal computer that they market.

And I think also IBM is doing that out of their center in Atlanta, where they are providing a lot of technological information for anyone who wishes it, in terms of accessibility to IBM equipment and others.

Based upon what they tell me, they are not exclusively marketing their own product. What they are is marketing technology to people who need it.

One of the other concerns I think that I have, it's not just making technology available to people with disabilities. I think we also have to raise our expectations, and by the "we" I mean we as a society in this country, that people with disabilities can, in fact, be employed, and can, in fact, live independently.

And if we can all agree on that more aggressively, and in a more public way and more public posture, I think we can then help technology to move towards that expectation, and that the funding source is needed to make that expectation a reality--can help us to achieve what we are all here talking about today.

We need to work with the advocacy groups of people with disabilities to do that, and those people that believe in what people with disabilities can do.

Clearly, we need to market the use of technology by people with disabilities a lot more than we have, and I'm sure that this Task Force intends to do that.

And I do think that there is a leadership role, if the Vocational Rehabilitation Agency can play in that regard, and I think there is also a leadership role that state governments can play and that the federal government can play, in terms of making those options a reality.

That concludes my oral comments for today, and Bob Sondheim and I are available for any questions that you might have. Thank you for the opportunity to speak on this very important matter.

MR. OAXACA: Thank you so much. Questions from the Task Force. Dr. Danek.

DR. DANEK: In thinking of trying to encourage more disabled persons to move into science and engineering careers, and by that I mean, graduate school, Ph.D. programs, and possibly, ultimately faculty positions.

I wonder, does rehabilitation, Vocational Rehabilitation Act permit you to provide graduate student support for disabled persons?

And two, if so, what are you doing to aggressively identify and seek out talented youth, let's say at the high school or freshman level that may, that are disabled, that may have the potential for [INAUDIBLE] science and engineering careers?

Are there any programs of that sort going on

[INAUDIBLE]?

MR. BARTELS: In terms of your first question, under the vocational rehabilitation program, we work with an individual to determine what is their vocational objective, and if their vocational objective is to be a neurophysicist and they have a high-level quadriplegia, for instance, and that services are needed from us in order for them to achieve that vocational goal, we have and we do provide such support.

And I can think of a particular individual who is now out in Denver, Colorado, who used to be at Harvard, who is now doing that.

DR. DANEK: You can't provide graduate students with scholarships and [INAUDIBLE]?

MR. BARTELS: Sure, we can, and we do. And we tie it to the vocational objective and the functional limitation of the disability.

DR. DANEK: And what do you do to work with high school students who are disabled to try to convince them that they ought to go into science or engineering, that they have the potential? Or do you wait until they decide?

MR. BARTELS: We pretty much at this point leave it to the vocational guidance they get in high school, and they would then come to us with a vocational objective in mind, and then we would work on that with individual vocational guidance, and then kind of package it.

We have not thought of ourselves as recruiting for science careers in the high schools, as we have not thought of ourselves as recruiting for any particular career. We pretty much deal with individuals who come to us and say, we need assistance.

DR. DANEK: What I'm after is the--leading up to a question that I would like your thoughts on. And that is, what if the National Science Foundation or some other agency came to the state rehab agencies and said, we are interested in encouraging more disabled students to choose science and engineering careers, and we are interested in doing like a Westinghouse Talent Search, a disabled students talent search for science and engineering potential.

Would the rehab agencies be willing to work with, let's say, the National Science Foundation and the counselors of the high schools in trying to identify disabled students at a high school level, and then develop tailored programs for them as they move on through undergraduate and graduate level on to a Ph.D. [INAUDIBLE]?

MR. BARTELS: I can only speak for us in Massachusetts, and I think I would welcome that as another alternative to help people with disabilities find their way in this world.

And certainly as a scientist myself, I would have benefited from that early on myself.

DR. DANEK: Well, unfortunately or fortunately, as that may be, in a sense it's good [SOUND OFF].

MR. BARTELS: Well, I was recruited to run the rehabilitation agency based upon the management skills I learned by being a middle manager at Honeywell, and also my experience as a disability advocate, both here in Massachusetts and nationally, which is kind of an interesting combination of skills.

I flipped my advocacy to being my career, and my interest in computers is now my hobby.

MR. OAXACA: Thank you so much for your testimony, Mr. Bartels and Mr. Sondheim, and thank you for taking the time to come down [SOUND OFF].

MR. BARTELS: Thank you.

MR. OAXACA: You hopefully are submitting all that in writing to us.

MR. BARTELS: You have a summary of my testimony in writing. You have my oral on your able machine, I am sure.

MR. OAXACA: Thank you so much. [SOUND OFF FOR 15 SECONDS]. My copy is...

DR. CRANE: Yeah, I thought I was--do you want me to go now?

MR. OAXACA: Yeah, my copy didn't have that thing yet, and so I have to recopy and so let me apologize. Dr. Valerie Crane, President of Research Communications Limited.

DR. CRANE: OK, I'm very pleased to be here today, and I would like to thank the Task Force and Mary Orlando for asking me here today.

The comments that I have for this group, I think, require some shifting focus, in terms of some of the other people who have been talking to you today.

First of all, there is a lot of discussion about moving into careers in science, and therefore the audiences that you may be considering are older audiences, students at the high school and the upper college level.

The presentation I have to speak to you about today focuses on youth, that it, children ages four through 12, looking at science, exposure to science, experiences at a younger age.

So that is the first departure that you are going to see in my comments.

Secondly, I am going to be moving out of the formal learning arena, focusing on colleges and high schools, and turning to informal learning sources.

The research that we do at Research Communications Limited focuses on a variety of informal learning media as they contribute to increasing public understanding of science and other areas as well, but I'm going to be focusing on science today.

As they also increase interest in these areas--specifically today we are going to be focusing on science.

Informal learning experiences are primarily delivered to audiences through television, various media, radio, books, and also through science museums.

And those are the kinds of projects that we look at as informal learning experiences, and we do studies to determine how does informal learning work? How does it contribute to the interest level that children and adults have in science, as well as how it contributes to increase their public understanding of science.

The third thing that I am going to do to broaden the definition of some of the problems that sit before you on this Task Force is to think beyond just selection of careers, because what is important when we talk about informal learning is also the whole area of science literacy.

And integral to providing informal learning experiences is to broaden the base and increase science literacy in our country overall.

I am going to be showing you a study that was done, supported by the National Science Foundation. They have an Informal Learning Division there, and it has provided some funding for a series called "3-2-1 Contact" that many of you may be familiar with, as well as "Square One Television," which is a math series for 8 to 12 year olds.

And I am going to briefly provide some findings from that study, because the focus of that particular series is to try to increase awareness, interest in science, particularly among girls and minorities.

That was a primary goal of this particular series, and the study that we conducted, with parents and their children, talking in 31 sites all over the country, pairs of children and their parents.

We talked to both boys and girls in this particular study...

MR. OAXACA: Excuse me, could you please make sure that you verbalize what is up there for those of us who can't see that far or at all.

DR. CRANE: Oh, OK, what I'm showing you here is the sample for our study. There we were actually talking to both boys and girls. Half of the children in our study were girls, and half were boys.

Also we looked at four to seven year olds who watched the series as much we found out as the age of 12 year olds, which is the target audience for this particular science series.

And also a major target in our study was to make sure that we represented both minority and non-minority children so that we could look at to what degree this series is reaching both of these important target audiences of the series, and also wanted to represent that audience to the degree that it is present in our total population.

Now the data that I'm going to be showing--I have just selected very, very few elements from the study. It is a much larger study available for your use, should you want to look at it.

One of the first things that we did in our study was to ask children how interested they were in science in general, in seeing programs, television programs specifically in science.

And the options were: Did they want to see this a lot?--which would have been a three. Did they want to see it somewhat?--which would be a two. And [INAUDIBLE] they really weren't at all interested overall in seeing science programming.

And when we processed our data for girls versus boys, we did find that boys, not surprisingly, indicated a higher level of interest in science and seeing television programming on science.

And we all--this was before we got into in-depth questions about "3-2-1 Contact."

We also looked at this item according to minority and non-minority children, and interestingly found that the minority children here on the left bar that you're seeing were actually more interested than the non-minority children in seeing television programming on science.

So there seems to be an appropriate targeting of television as one way of reaching young children and trying to intrigue and interest them, utilizing the television media.

Now, moving on to some of the things that we found out about this series, which has now been on the air over five years.

We, first of all, wanted to find out to what degree is the public aware and has ever watched "3-2-1 Contact," and we found that in fact 64 percent of the children in our sample of 410 had actually watched "3-2-1 Contact" at some time. That is a science program that is available every single day. It is a five day a week series, and that is an incredible thought to think that there is a majority of the children in this country have an opportunity and actually are exposed to at some point science programming.

Although we found that boys reported they were more interested in seeing science programs, it was also very interesting for us to note that both girls and boys had seen the program with equal frequency, so that while boys may be interested in programming, we are finding that the girls are still sampling it with equal frequency with the boys. That's the major goal of the series.

We also found that the four to seven year olds were seeing the program with equal frequency to the eight to 12 year olds on the second set of bars that you see here.

So that although the primary target is being reached, younger children are also watching. And this important audience of minority children, we also found that they were watching, and had been exposed with equal frequency to the series as have the non-minority students.

So that very important target really is being reached, as indicated by our data.

We also analyzed a series of measures to see whether or not children who may not already have a very high level of interest in science would ever be exposed to this particular series and see it.

And we did find that children who had a high level of interest in science, and those who had a low level of interest in science, actually has been exposed with equal frequency.

So that in terms of the job of trying to increase science literacy, we see the general range of audiences that are reached, utilizing the television media.

We also asked the question about frequency here, dealing from very frequently down to infrequent, and this is actual time questions that we ask. But, again, it reinforced our findings, that both girls and boys were watching the series with equal frequency, even though boys were more interested in science, coming into the loop, that both boys and girls were watching with equal frequency.

We also found in the second of the yellow bars that you see here that both minority and non-minority students were watching with equal frequency.

But the one thing we did find a difference on, as we did throughout our study, was that parents who had a high level of interest in science tended to have children with a high level. Parents with a high level of interest in science were much more likely to have watched the series than those who have a low level of interest in science.

That reinforces what we often find in these studies of informal learning. That is, the parents' interests that really drives what the child actually does and the degree in which they participate in science activity.

That makes television particularly important in trying to make different kinds of science and math information accessible to all children, because the parents play such an important role.

We also asked parents why their children watch, and parents said the boys were more likely to watch because of their interest in science. In other words, that's what drove their viewing.

Girls, they were less likely to say it was because of their interest in science, but once their girls got into the process of watching that they became intrigued with the series and actually did come back for more.

We also asked how much they enjoyed the series in general, and this was again an item where they enjoyed it a lot, a little, or not at all. And we found that both boys and girls said that they enjoyed the series with a comparable level here, and both of them reporting high levels of enjoyment and appreciation for science in the program.

We found that both younger and older children had equally high levels of enjoyment of the series. So even the younger children, who aren't the main target, you can see there is an opportunity across a broad range of years to be reaching children with this series.

The next group that we look at here for enjoyment, both minority and non-minority students reporting that they enjoyed watching the series, and finally, not too surprisingly, we did see a difference between those who have a high level of interest in science versus those that have a lower level of interest in science.

But what was important here is that the low level of interest in science still resulted in fairly high levels of enjoyment for "3-2-1 Contact." Again, that being an important goal of the series--can we bring more children into the science community?

We also saw something very interesting in our studies. We wanted to ask questions about what happened as a result of viewing. It's nice to say to the children, enjoy this, but does anything happen after they watch this show?

And we asked both parents and children what did happen, and we found interestingly that 61 percent of the parents said that something happened as a result of viewing.

Television is often criticized as a very passive medium and one that doesn't encourage children to do anything beyond just sitting and watching.

We asked parents what kinds of things these children were doing after watching. Nine percent said that the children read a book as a result, 4 percent did an experiment, 4 percent solved a problem, a few were actually doing some kind of building as a result, 6 percent made a trip somewhere to a museum or wherever.

But three out of 10 said, out of our total sample, that they were doing a variety of things, a range of different kinds of activities, and we have many verbatims from the parents which indicate the many different kinds of activities which result.

And that indicates that while children are having an enjoyable experience by watching the show that they do something as a result of it. That is a powerful indicator.

We actually showed an episode of the show to the children and found again that the children--girls enjoyed the episode as much as the boys did, that younger and older children [BELL] both enjoyed what they had seen.

Minority and non-minority enjoyed it with equal frequency. High science interest, again, also enjoyed it as much as the lower interest.

We also measured content in this particular study, wanting to see, what did they learn as a result of actually viewing?

We found that boys learned the same amount as girls. There was no significant difference in what they actually got from the show. We did find there were no differences regarding high or low levels of science interest.

The only variable that we did see a difference in terms of the content scores were parents who had a high level of education, not surprisingly, their children performing better than those children with a low level of education.

We also noted a higher level of learning among the non-minority students, but when we did special statistical analyses, we found that those differences disappeared in terms of learning when we controlled for parent education.

So we were seeing substantial learning on the part of both of these groups.

And then we also learned that children who learn more also enjoyed the series more, that enjoyment was related to learning, that if they had studied this in school, they also resulted in higher levels of learning.

And children who felt that they had learned something actually learned more than children who felt that they had not learned something as a result of viewing.

We also, in our final slide I am going to be showing you, we asked whether parents felt this had a positive to negative attitude on the science attitudes of their children. As you can see here, the college educated parents gave a very high level, very high vote in terms of the positive influence of "3-2-1 Contact."

Those with some college, those with no college, all of them really saying they felt this series, were positive and had a high level impact.

There were also income differences, but what we found is that a range of audiences were telling us that this particular series had a positive impact on their children regarding science attitudes.

I would like to part with a message in terms of what the Task Force might [INAUDIBLE]. Informal learning is [INAUDIBLE] reaching children and in reaching adults as we are trying to increase public understanding of science--increase positive attitudes towards science, as well.

MR. OAXACA: Thank you so much, Dr. Crane. Any questions by the Task Force. Yes, Ms. Jill Emery.

MS. EMERY: Dr. Crane, I just have a few real quick little questions. For example, what time of day is this program shown on television?

DR. CRANE: It varies in markets all over the country, but the ideal time slot is usually a 5-5:30. It is usually an--it is an after-school time slot daily.

MS. EMERY: And is each program followed by the next one, on the previous?

DR. CRANE: Yes, in the case of "3-2-1 Contact," they have theme weeks, so they organize the contact around themes, such as oceans, and they will focus on that for five days.

You don't need to have seen, in most of the programs, one program to see another.

MS. EMERY: Is this shown during the day also?

DR. CRANE: Many of the--during the day--after school it is shown. That's the...

MS. EMERY: Well, just after school. It's not shown during the [INAUDIBLE]?

DR. CRANE: It is also in--yes, it is--it is also shown in many instructional television, school television line-ups so that it can be used during the day by teachers.

And actually we did a study of the teachers in addition to this, but I don't have time to cover it all.

MS. KEMNITZER: May I make a comment here, at the risk of indulging in a little personal story. In February of this year, I had our distinguished Co-Chair and Dr. Graham, the Science Advisor to the President, over to my home for dinner one evening.

My boys are regular watchers of the program, and the power of the program, I think, can be attested to the fact that the whole dinner party sat down and watched "3-2-1 Contact" during the cocktail hour, after which time the two men of the group helped my children play with their electric trains.

So, seriously, as a parent, I can say that "3-2-1" is a wonderful show for everyone, and they have done a remarkable job of--as the study indicates--balancing out the male-female, minority-non-minority--even handicapped scientists are represented now.

So its really something to be commended, as is Dr. Crane's study.

MR. OAXACA: Even if it is not in Spanish, it is a hell of a program. I'm kidding, it was a very fine program.

Dr. Danek was mentioning that it is not shown in Los

Angeles.

DR. CRANE: That's right. Each one of the stations in the public broadcast system has the right to air or not air a program, and it has been removed. However, sometimes the changes in schedule are a function of reruns, how many times the program is rerun.

So you have to look very carefully that it may reappear in the fall, it may not.

DR. DANEK: Are you having, you're talking with the Los Angeles School District?--a number of people are trying to increase kind of local awareness of the value of the program and its relevance for Los Angeles.

DR. CRANE: It is important for me to point out that I am not from Children's Television Workshop and have nothing to do with that organization. My research study was supported by NSF separately.

I happen to do a lot of research in the area, so I know something about the--both the commercial and public broadcasting system, but that's not my purview.

I think they are trying all the time to connect back in the school systems and more importantly, it is supposed to be an informal learning experience to broadcast schedules.

MR. OAXACA: Thank you so much for your testimony.

DR. CRANE: Thank you.

MR. OAXACA: Now back on the format that I have. Dr. Harlee Strauss, a Senior Associate of the Gradient Corporation.

Welcome to our Task Force and thank you for taking the time.

DR. STRAUSS: You're welcome and thank you for inviting me today.

I am here representing myself and the New England Chapter of the Association for Women in Science. AWIS New England has more than 120 members in this region in the life, social, and physical sciences.

My testimony today concerns the barriers many women are facing in their research careers. I will particularly focus on the time frame between earning a Ph.D. and decisions regarding tenure or promotion in academia.

My testimony, which is based on anecdotal information, is drawn on both my own experiences and those of my AWIS colleagues, whom I have informally polled to put together this testimony.

Identifying and decreasing the barriers to women in research careers is one of the many difficult tasks facing this committee. The difficulty lies, in part, in, one, the subtlety of many of the barriers, and two, the intimate linkage of these barriers with the prevailing political and social structures and with societal values.

The results of my informal survey of women scientists, regarding the barriers they face to either entering or pursuing research careers, can be categorized into the following areas:

Structure of the system, including time to do research;

Access to research funds;

Access to graduate students, post-docs, or technicians;

And lastly, recognition and visibility among peers and leaders in research specialties.

You will notice that many of these points were covered this morning as well by professors Widnall and Dresselhaus.

The first category, structure of the system, is cited as a reason by many for not entering or for leaving research science. Women in tenure-track academic careers, like their male colleagues, allocate their professional time between research, teaching, conferences, administrative responsibilities, and committees.

This is much more than a full-time position for anyone, male or female, and at least in the early stages of a tenure track position, there is little time or flexibility to retain any outside interests or activities, be they participation in organizations, raising a family, or caring for an aging parent.

Indeed, since women in academia don't have wives, even finding the time required to go food shopping and doing other household chores can be a problem.

The structure of academe seems to assume a two-adult family unit. One, traditionally the male, to perform the academic work, and one, traditionally the female, to assume a full-time support services role.

Both women and men face this assumption. However, our social system and social values assign the role of caring for children to women, and although men in some families with two working professionals are assuming many more of the responsibilities, it is still a very rare circumstance when men assume more than half or more of the support role.

The system for advancement is based on a combination of competition and team camaraderie, in which most males have been trained since elementary school.

But team sports training has only recently been open to females. Moreover, the camaraderie aspects of sports and other team training are generally single sex.

Thus, when men think about who they want on their permanent team at tenure time, they think of the men in their department. This problem results in, and is exacerbated by, the small number of women in powerful positions in the research establishment.

Neither men nor women have sufficient number of role models of successful collegial women scientists in highly visible positions.

The academic reward system is largely based on research productivity, which requires time to do research. Here, too, women may be at a disadvantage compared to their male counterparts.

For example, some women said they are on more committees, both inside and outside of their institutions, than their male peers.

While we all believe it is important for women to be on committees, the smaller pool size of women to draw from places increased burdens on those women who are there.

Other women I spoke with said they spent more time advising students, especially women students, than their male peers. This can be a more time-consuming and less recognized activity than committee work.

Of course, not all women researchers in academia are on the tenure track. Many women are in soft-money research or teaching positions, with titles such as research associate, instructor, research assistant professor.

Women enter these positions for many reasons. For example, off-track positions may be the only viable option for remaining in a research career, because of inaccessibility to tenure-track positions.

Other women may prefer these positions because the demands on their time may not be quite as great.

In any case, these research positions are not accorded the status and prestige of the tenure-track positions, and present different challenges to the pursuit of a successful research career.

This includes obtaining research funds, which I will talk about in a minute.

As I mentioned earlier, the academic structure and particularly the time requirements were cited as a major factor in the decision of several women I spoke with who either opted not to pursue or not to remain in academic research careers.

For example, one of our members became a high school science teacher after M.I.T. Ph.D. and post-doc at Harvard. She wanted to have children and saw the demands of a career in academic research as incompatible with the time she wanted to spend with her children.

The primary issue here was not the availability of good child care, although that was important, but rather it was the availability of time to spend with her children.

It seems that women who are in a position to have research careers are resourceful enough to develop adequate child care arrangements, although doing so takes time and money and effort.

These observations have several implications in terms of developing programs and policies to retain women in research careers. For example, it suggests that improved and affordable child care programs are important for freeing up more time for those women who have selected research careers.

But the availability of adequate child care alone may not increase the recruitment of women scientists into research careers. More fundamental changes in job structure are required to accomplish this.

Changes may include part time, but tenure-track positions with appropriate extensions of tenure or other promotion decisions.

Increasing the status of research track positions and job sharing are other possibilities.

These observations also suggest there is a pool of women scientists who may want to return to their research careers once their children are grown.

Re-entry programs, or special fellowships, could and should be developed to help women who wish to return to research careers.

Access to research funds is a continuing problem for women researchers. There is still at least the perception that women have to be more than equal to get their funds granted--get their grants funded.

This inequality of funding, whether it is real or perceived, may be inhibiting some women from applying for research funds at the major granting agencies. As you know, a few years ago, the National Science Foundation started its program, Research Opportunities for Women.

I recall that in its first year the program officials at the NSF were surprised by the number of excellent grant proposals that were submitted through the ROW program.

These proposals, which would have been competitive in traditional NSF programs, would not otherwise have been submitted to the agency--to the foundation.

Thus, one of the accomplishments of the ROW program was to bring capable women researchers into the NSF process. The NSF program could be adopted by other funding agencies to facilitate the entry of women researchers into their normal grant processes as well.

Obtaining one's first grant is a major milestone, but it is not enough to secure a long-term research career. Grants have to be renewed and additional grants from other sources are usually also necessary.

Understanding grantsmanship is an area where many women seem to be at a disadvantage compared with their male counterparts. This partly arises because grantsmanship is part of the informal training process, such as discussions after meetings and after softball games, to which women still have less access.

Access to research funds is a particular problem for the many women in marginal positions in academia, those with titles such as research associate or research scientist.

These non-tenure-track research positions often do not carry the privilege for applying for funds as a principal investigator. The roadblock here is not at the level of the funding agencies, but in the policies of individual academic institutions.

However, it still may be possible for the federal funding agencies to exert pressure on academic institutions to allow scientists in these positions to obtain funds in their own name.

Recruitment of good graduate students, post-doc researchers and technicians to the research laboratory is critical to achieving the scientific productivity required for tenure and other scientific recognition.

However, here, too, women scientists are not always on a level playing field with their male counterparts. There are still students and post-docs who do not want to work for a woman.

There are many possible reasons for this. For example, there can be the perception that a woman will not have as much clout later on in assisting with job placement.

In addition, good old fashioned sex discrimination still exists.

There may be other subtle reasons as well. For example, there may be a perception that the woman, a research--that the research a woman is doing is less interesting or less important than other members of her department.

External recognition of one's scientific accomplishments is essential to advancement in a research career. However, achieving this recognition seems to be a particular problem for women in all stages of their careers [BELL].

The problem of recognition is seen in many contexts, from the familiar settings of research groups to the selection of keynote speakers for international conferences.

It is also seen in the salary differentials between men and women scientists.

As an example, many women note that they make important comments in group meetings or seminars that go unrecognized. A few minutes later, when a male colleague repeats the same comment, everyone agrees with it, and gives him credit for the observation.

These subtle and not-so-subtle slights have been mentioned by almost all the women I spoke with. They are small in and of themselves and most of the time the affected woman is uncertain whether she is being discriminated against or being paranoid.

However, the frequency and universality of these experiences among women scientists make a strong point. Although many forms of overt sex discrimination have disappeared, the subtle ones remain and continue to take their toll.

Lack of recognition or reduced level of recognition of the accomplishments of women scientists continue throughout all career stages, but in different forms.

Women are less likely to be invited as seminar or symposium speakers--as discussed this morning in mathematics, to write book chapters, to be members of editorial boards, or to be nominated for important awards.

And, of course, visibility builds more visibility, and so lack of visibility in early career stages leads to even greater disparities later on.

The reduced recognition of accomplishments of women scientists is deeply tied to the social climate of the times. I don't think most male scientists are engaging in malicious behavior to exclude women. They just don't think about it.

And there are no social strictures against this omission. The lack of enforcement of federal antidiscrimination laws in the past six or seven years has contributed to this situation.

I would like to actually now, at the end of my talk now to respond to a comment this morning brought up by Millie Dresselhaus, that is the importance of identifying and matching qualified women with openings for committee work and other areas of recognition.

The Association for Women in Science at the national level did have a registry of women scientists that they maintained for about 10 years. They were seeking funds to expand it and put it on a computer, and they were trying to do that through the WEA program.

They never got funded for that and this project has since disappeared.

Thank you.

MR. OAXACA: Thank you very much. Questions from the Task Force. Yes, Ms. Joseph.

MS. JOSEPH: I would just like to know how many people you polled and were there any minority women, and about what the age group was of the women you [INAUDIBLE]?

DR. STRAUSS: The women I polled were members of our chapter, and I polled, I would say, 15 or 20 of them. No, there were no minority women involved. The age ranged from post-docs of mid- to late twenties--I was concentrating on the twenties and thirties. I did talk to a few people who were full professors at this point.

It was a very non-scientific sampling.

MR. OAXACA: Yes, Ms. Morgan.

MS. MORGAN: When we speak about increasing the pool of scientists in this country, we talk about improving education. And I'm curious about your colleague who chose to teach high school with a Ph.D.

And I have two questions. One, does she enjoy what she is doing? And two--three questions--two, does she feel like she is making an impact? And three, does she find that she is spending much less time than she would as a research scientist?

DR. STRAUSS: Let me take them in backwards order. I think she is spending less time, but she still feels sometimes it's too much apparently.

I think she is enjoying it. She would also enjoy a research career, and she is talking very much about going back when her children get older.

I should say that there is a--she is teaching at a private high school because she can't teach in a public high school. And there are three women Ph.D.s on the science faculty of this private high school. Two of them had had--were professors, in tenure-track positions at local universities, and opted out, and saw high school teaching as a job they could have during their child-bearing years.

But they would rather be in a research lab, but there was no option for them to do that.

MR. OAXACA: Thank you very much for your testimony. I would like to ask Dr. Lilli Hornig, Cheever House, Wellesley College. Thank you so much for taking the time to come and testify before the Task Force.

DR. HORNIG: Thank you very much for giving me this opportunity to do that. Small correction, it's Wellesley College. It's a women's college, not far from here.

With your permission, I would like to skip over my prepared testimony which you have copies of, and the detailed attachments to that, in part because much of what it says has, in fact, been said by other people today, and I am aware that I am following several acts that are hard to top, and that time is running short. I will try to be very brief.

I have a lifelong association with the problems of women in science, now just about 50 years, counting from when I started college, and I have--my own degree is in chemistry, and I have been on the faculty of Brown University and chaired a department at Trinity College in Washington before becoming really actively involved in the early 1970s with the specific problems before this commission.

I would like to make a couple of general points that have really struck me in listening to other witnesses today. The idea, the stereotypic idea that there aren't enough somehow, whatever enough is, women, scientists, and engineers and mathematicians rolls all too glibly off everybody's tongues.

The fact is it's not so. There are, in fact, more women scientists and mathematicians and engineers, when you put them all together, than there are people in similarly advanced places in other professions, such as the humanities, for example, because the professions are larger and the proportion of women seems smaller in these very big fields.

Nonetheless, for example, I would like to point out that there have been more women Nobel laureates in the hard sciences than there every were women in literature or getting the peace prize or the very few other fields that these prizes are given in.

Still, they are nowhere near in proportion to the number of scientists who are actually working, but I will not elaborate on that now.

The point I really wanted to make is that I think it is becoming increasingly harmful to say to young women, to girls in school, that this is a kind of pioneering thing we want you to do. It's not. It is a way to make a living, among other things.

And it is important for them to understand, and for their parents to understand that although they may meet discrimination in pursuing careers in science and engineering, they will meet discrimination in whatever field they enter.

It is equally true in medicine, in law, in business, in any profession, in any blue-collar job you want to name.

People need to understand that. The basic problem is to focus on discrimination and not on a field in itself. The reason science and technology is currently of interest is very much what there is--what many people see is a national shortfall in the numbers of scientists and engineers we're training, I do want to add that there is still a finite percentage of unemployed scientists and engineers in this country, and it is not demonstrable that we have an active kind of shortage.

I was asked to speak about graduate education. I do want to address, in that context, a very few individual topics. They have to do with the pipeline issues that have been a continuing threat throughout the day.

The pipeline has a couple of problems. It has a filter at the beginning, and it is one that is no longer much recognized, but it is precisely a consequence of many, many decades of discrimination.

It is a remnant of the fact that we used to have heavily male-biased major educational institutions, the one that is hosting our meeting today is, of course, one of them, and its current freshman class contains 40 percent women. That is a matter of policy at this institution and at almost all the other formerly all-male institutions with which I have been associated in one way or another.

It is true, incidentally, at the major flagship public universities, just as it is in the private ones.

There are demonstrable--second point--demonstrable inequalities in financial aid for women at the graduate level. There are also inequalities at the undergraduate level, but that is not my area of expertise.

In the graduate fields, the situation is that outside help from federal--largely from federal sources, some from university sources directly through TAs--other aid comes as research assistantships funded by faculty research grants, and a few sources of direct government aid, a few federal fellowships, NSF, and of course, traineeships in the life sciences.

But these, this federal largesse of public money is distributed very unequally across fields. It is concentrated in the physical sciences, to a lesser degree in the life sciences, less again in social sciences, and almost nonexistent in the humanities and in education.

The result of that is an interesting curve, which I will furnish for you if you want it, that the amount of personal funds that a student, whether male or female, in a graduate field has to contribute is proportional to the percent of women in that field. That is a really startling correlation.

I am not suggesting that it arose because somebody designed it that way. I am not suggesting that someone sat down and said, we need to support the sciences because there are very few women there, but we will not support the field of education, which is well over 60 percent female now. I don't think that's how that happened.

There are other inequities that have a long historical basis, primarily the support given by the GI bill, which still supports around 5 percent or so annually of men earning Ph.D.s, and essentially none of the women, very few.

Possibly--and we have been talking in terms of filters and pumps all day--I like to think of graduate financial aid as a pump mechanism. People come along from undergraduate college. It is no longer a question of career choice, it may be a question of level of aspiration in the chosen field.

And the provision of financial aid, which has been freely given for the last 35 years to men in these fields, was initially viewed, in fact, as an instrument of national scientific manpower policy--and "manpower" is the operative word.

It would be my contention that it will work with equal effectiveness on women and on minority students, should the government see itself forced to try that out.

In addition to these defective pumps in the financial aid mechanism, there is a problem at the end of the pipeline, and that is, I think without question, the worst one. It's that there is a semi-permeable membrane there. Men go out and women don't go very far.

The pick of the possessions at completion of the Ph.D. across the board in every field goes to men, and there are 16 different ways to demonstrate that in the data, and I don't want to bore you with the details. I would be happy to answer questions about that.

The--certainly the belief that there is worthwhile job to do at the end of a great many years of education is what pumps that mechanism along. No one in their right mind, least of all anyone bright enough to be a scientist, would go through graduate school in those fields if they didn't think they could go on doing it.

Now it isn't just a question of having a job that will pay to support you, it is an activity that you entered because you wanted very much to do it, and it is a very hard business to find at the end of all that time that your opportunities [BELL] to do that are very limited.

Let me turn now to what I think might be done about some of this very quickly.

We need to clean up the pipeline, fix the pumps, get rid of the semi-permeable membrane--and the way to do that, I think there really is only one way, and that is to, somehow, inspire our leadership at the national level and in universities to once again confirm a commitment to moral leadership in the area of equal rights for everyone.

We have not had that kind of leadership in some time at the national level, and in the universities, I'm afraid that the leadership that may have existed in a few places has, in the end, been frittered away on nitpicking arguments about how you are going to implement affirmative action, and how you can maybe weasel out of some of the requirements and how you could tailor your plans so you weren't really going to have to upset anybody's apple cart.

We need to enhance that climate, and I think the federal science agencies have an absolutely key role in this process. They won't like everything I want to say. I think they should bear some of the responsibility for monitoring the projects that they fund.

I think they should require, when there is an education project at any level, that there be equal participation by women, by little girls, by minority children, whatever reflects the composition of the population of the community in which that program is taking place.

The same thing ought to occur at the university level, in research funding. There is no reason why the research associateships that support so many graduate students in the science fields cannot be, could not be made a requirement that these be equally distributed among the students, and without regard to sex or race.

These are legal requirements. We ought to be enforcing them at least in the employment of public money. I have one incentive suggestion to propose, funding for undergraduate research has been added, as an incentive measure, to a number of kinds of programs funded by the National Science Foundation.

I would like to see research support for women graduate students set aside in the same way and used as an incentive to convince research faculty that this is a thing they must do and it will be to their own benefit to do that.

Finally, on quick sentence--we need to respond to the many problems that have been raised about child care and family responsibilities. We need, in this country, finally, a comprehensive social and family policy that will allow everyone to contribute to the work of the nation, and will, in the process, not harm our children.

Thank you.

MR. OAXACA: Thank you so much for your testimony. Questions from the Task Force, please. Mr. Norbert Hill.

MR. HILL: Just a question on your research. Did you have any data on minority men compared to the progress of majority women, in terms of tenure or access to opportunities?

DR. HORNIG: I have a little. There is a little available. Some of it--I guess probably most of it, not in the sciences, however. It tends to be in the humanities and it is available in the institutional studies--I forget for a moment what they were called--done by the ACE.

They have done study, I know in the field of history, which shows a--which incidentally behaves much like one of the science fields demographically--shows a clear, usual clear advantage for white men, then minority men, then white women, and finally, minority women.

MR. HILL: That's the lineup.

DR. HORNIG: That's as clearcut as you might want to see.

MR. OAXACA: Ms. Bishop.

MS. BISHOP: Dr. Hornig, I was just wondering if it would help us excite folk at the top, if you will, get excited about what we see and what I am hearing you say as a problem that cuts across not only in science and technology, but the whole area of discrimination and equal rights.

What kind of excitement, what kind of energy do we do to folk at the top, who I believe would have the power to effect some of this, whether they are presidents of universities, heads of agencies, the President himself.

There has got to be something that we are going to have to do to get their attention, lest we be accused of coming out with another position that is like everything else that we have been hearing over the years.

Do you have any thoughts on that?

DR. HORNIG: I don't think I have any earthshaking suggestions. That's a hard problem. I do think that groups like yours can have a lot of impact. People are listening. There is widespread, I think, interest in these problems.

There isn't necessarily at the moment the will to do very much about them. But I think we are going to, in the next year or so, I think we are going to be reorienting national priorities in a quite fundamental way.

I think whichever way the election comes out--that is not the only part of it. People are clearly thinking again about the social problems that they were so concerned with 20 years ago, and I think it is an opportune time to make ourselves heard and to find whatever places we can to do that.

Obviously a situation such as Dr. Widnall provides during the year she is President of AAAS is a unique opportunity to inject these issues again into the ongoing debates of the field.

MR. OAXACA: Dr. Brasel.

DR. BRASEL: Yes, I would like to make a comment, share concern, and get your reaction [SOUND OFF FOR 18 SECONDS] set-asides and the other area you mentioned in that regard.

DR. HORNIG: It's--I have reversed my position on that. I used to think, just as you just explained that this was not either a politically sound thing to do and also that it tended to make women and, I thought, minorities also feel put down in a way.

I don't think that has been the experience with the set-aside programs for women at NSF. I don't think it's been the experience at any of the institutions that have, in fact, had such fellowship programs of that kind.

I think somebody mentioned that this morning, that at MIT they are among the most sought after and prestigious kinds of awards. I think that is the situation one needs to create.

I was a member, a charter member, of CEOSE at the time that the more recent programs came in, and I remember how impressed a lot of leading administrators were when the officer who was in charge of it at the time of the program, at the time described the enormous number of applications and the fact that they were heavily concentrated in mathematics, where, of course, nobody expected any, really.

Everybody had expected ahead of time that half of them you would have to throw away because they would be in behavioral science, not fit NSF.

It didn't turn out that way, and I think it hasn't since. They have been marvelous programs, and I think that is the kind of credibility one has to establish.

MR. OAXACA: Dr. Shirley Malcom.

DR. MALCOM: [SOUND OFF FOR ONE MINUTE] they are tied to grants that come from federal sources, and I think the [INAUDIBLE] really across the board.

DR. HORNIG: Yes.

DR. MALCOM: And the question I wanted to ask you is, this whole issue of, for example, discipline-specific intervention, because, as I look at chemistry, your field, and as I look at major research university chemistry departments, I see huge discrepancies between the [INAUDIBLE], the proportions, the large proportions of women who are in chemistry with Ph.D.s, many given by those same research institutions on the one hand, and the presence--maybe I say the absence of women on the tenure-line chemistry faculties, you know, in those same research universities.

And I am wondering whether there is a, whether--what ought to be the balance, for example, and the target between more general kinds of remedies on the one hand, discipline-specific remedies on the other.

DR. HORNIG: Oh--there are--you have mentioned one of the disciplines, chemistry, that shows enormous discrepancies in the great variety of ways. Mathematics is about twice as bad on a quantitative measure.

Just in passing, there is somewhere around 35 to 40 percent of all undergraduate mathematics degrees go to women, and only currently about 18 percent, I think, of the Ph.D.s, and that is in relation to the two types of enrollment. That is about a 50 percent attrition rate, compared to men.

Those things are very closely tied, I think, to financial support. There are details of the financial support picture that are very difficult to get at. As far as I know, nobody knows dollar amounts.

And you can talk about these sources, get some very dull discussion because you are always talking about relative proportions changing and different ratios, and it is very, it is kind of hard to follow.

But there are big disparities in those two fields, and several kinds of support. You are absolutely right in mentioning, and I should have mentioned it sooner, that the minority situation is worse, that minorities are, in fact, contributing more personal funds to their graduate education than the majority students, and it is quite clear that they have actually less to contribute.

There are--in those last two reports that Shirley mentioned, there are interesting correlations between degree completion times and amounts of financial aid and types of financial aid--not amounts but types of financial aid available, because it is very clear that if you are an RA, then the work for which you are getting paid is the work that furthers your dissertation and your whole professional career, and you're spending all your time in the lab with your peers and your mentors, and if you are a teaching assistant, you are spending an equivalent amount of time that you are being paid for--let's assume they're equally paid--with undergraduates, most often freshmen and sophomores, who have very little to contribute to your professional development.

In the meantime, you are not making the contacts that you ought to be making among your peers, and you will never become a member of that gang in the lab. And you are sent off on your own. The faculty clearly somewhere thought that you belong in teaching, and that teaching is not a highly regarded activity among scientists, I'm sorry to say.

MR. OAXACA: Dr. Adams.

DR. ADAMS: I think it's just imperative that we understand that, what you have just ended up saying, because agencies as they thumb through research dollars, if you don't, if you're not tied to the [INAUDIBLE], you are automatically at a disadvantage.

If you are tied to a professor--you do not get a science degree unless someone kicks you out with your dissertation on a research project [INAUDIBLE].

We fund graduate education in the sciences through research dollars, and minorities and women do not get those funds. They do not get those funds.

And any of us sitting around this table have to go back within specific organizations and talk about that. When you talk about DOD and DOE and those kinds of funds, Department of Commerce [INAUDIBLE] administration, those funds go directly to the universities on research projects. We have been arguing about that a long time.

And until we can get the language that says that minorities and women must participate. Last year, of foreign students who got Ph.D.s, they got 75 percent of their funds from the university on TAs and RAs and about 50 percent of those were RAs, which are research assistantships, which means you are tied to a topic--to a professor, and that's why they get up.

And I have been arguing about that [INAUDIBLE] with deans and if any of your have heard me talk about this, this committe has to take a strong position on that. It has got to be a part of the language of policy.

Otherwise, when you come back and try to argue for it, it's against the law. It's discriminatory and you get no money whatsoever. And I have been fussing about that for 10 years. We cannot even get anybody to understand that.

MR. OAXACA: You gotta do more than go have the agencies talk about it. You know, they have been talking about it for decades. I think you gotta go get it fixed, as opposed to talking about it. Philosophy doesn't go too far these days.

DR. HORNIG: I would like to make a comment in response to that. It's clear, if you look at the evolution of research funding over the last 40 years or so that it started out to support education through research.

It was a wonderful concept, and the whole world wanted to imitate us. What we lost in the process and over the 40 years is the education part of that. We are turning out research. We are now worried that we are not turning out enough research and not turning out enough scientists.

And we have looked everywhere except in the place that says we are not educating them on the way to become the kinds of scientists that are productive.

And I think that assessment needs to be made again.

MR. OAXACA: Thank you very much for your testimony.

DR. HORNIG: Thank you.

MR. OAXACA: I would like to ask Dr. Margaret Rossiter, Visiting Professor of History of Science, Cornell University. Welcome to our Task Force. Thank you for hanging around all this time, and thank you for your time.

DR. ROSSITER: Thank you very much. It's nice to have a reason to come to Cambridge and it's doubly nice to meet with your distinguished panel.

It is a challenging exercise for a historian, who is usually buried in sources of the past, to lift up her head and try and think about the future, or somewhat flattered to think that maybe what we work on has some relevance once in a while.

And I guess the main point is it's not fiction. We work very hard to get the facts right, to dig things out of old data, obscure archival records, and so forth.

And you can find about what did happen. You can find about what was going on in private, people who were collecting data on how many Jews we have at our school or how many women we have or how many minorities, all kinds of things they wouldn't have said in public at the time, you can find the records.

And also you can find about things that didn't happen. The protest movements, the alternative thoughts, led us to the editor that didn't get published, all sort of alternative view of reality.

So the sources are incredibly rich, and historians are alive in the present, they read the newspaper, they interact, they vote. But then they go to the libraries and they read old books.

And, as a historian of science, a long time ago, about 15 years ago, I got into the history of women scientists, and I can tell you that many people said there was no such subject, there never would be much material, but yet the sources are incredibly rich, and it's all there.

And there are a few Blacks in the footnotes--they are coming along in the 1920s and 1930s--and there are a few handicaps, especially deaf women would work in, like, the Harvard College Observatory, and handicapped women who have polio and would work in various laboratories--people felt sort of charitable in hiring her, to let her help out on their research project.

But when I think about the future, it will have some resemblance to the past. It won't be quite the same. In many ways, we are in a whole new world, but they will be old patterns, because the people will be those we know who have been socialized for the 1950s, 1960s, and so forth, and they will still be with us.

And I think people shape new events to fit the familiar. They sort of base things on precedents. They set up new agencies that have a mission--the Manhattan Project or something else.

So they think about past analogies, and then they also probably react in similar ways to new forces and similar forces coming along--wars, depressions, reactions, and so forth.

And I think perhaps institutions even more this way than people, that they have memories, they have an ethos, they sort of have a certain viewpoint of doing things, and they probably don't change all that much.

I could say in general that after good times, some periods of expansion, you have to expect plateaus, consolidations, and reorganizations. And they aren't always as neutral and gender-free as you might like to think.

And then also there has been a great article by a historian at Princeton, it says that after ideological strategies and stages, you tend to have shortages.

And she talked about the Ayatollah Khomeini, Stalin, Hitler, and a few others that they think that they are controlling society by controlling their women, and things get worse, and pretty soon there is a shortage, and the women they were, you know, putting in veils they now need as doctors.

So that ideologies come and go, and then there tend to be shortages thereafter.

I put a handout at each of your places and [INAUDIBLE], coeducation got above 40 percent before, around 1900, there were cutbacks at various places, not everywhere, but the signs of this would be phasing out nursing and building a stadium, or merging pharmacy and nursing and a few other things and putting up other more masculine-oriented projects, as a way to attract more male students.

The women's colleges were very important in the past, not only as trainers of prominent women, but also as employers, and I'm fearful what is going to happen when those who have gone newly coed start to refashion their faculties.

Job ghettoization is something I think is probably lurking out there, that when a lot of women get trained in new fields, they don't necessarily rise to the top. Somewhere in the middle they get sort of lost, and maybe they start their own little companies, maybe they like bossing other women.

And this happens when they leave the pioneering area and go back to something else more traditional, or when their whole field gets labeled as second rate, low quality, and has to be eliminated.

And as a phrase that was common in the past--raising standards--that almost always happens when there are too many women in a field. People would come along and say that this is second rate and we have to beef it up.

And that was a code phrase for masculinization in many cases.

I am also worried about women's organizations. All too often in the past, in the 1930s even, they will say the problems are solved. We are going to disband our group.

And looking back from current decades, you wonder what in earth was going through their mind. I think basically they were tired and it was harder and harder to keep raising money.

It was a brain drain in the sixties. I think it favored foreign men much more than foreign women.

A lot of college towns where there were Ph.D. women--Lawrence, Kansas; Ames, Iowa, these places--foreign men came and became professors of chemistry, while wives of people who were there were told they had anti-nepotism rules and they couldn't be hired.

So I am fearful that with current situations we might have a brain drain pretty soon and then there will be things to be worried about.

The national academies don't seem to be increasing their numbers terribly much, despite the great influx of new female talent.

Optimistic moments, I think our institutions reflect our society, and I also think America, starting in the 19th century, was leading the world in the percentage of women it educated, and to the great heights that many of them did get educated by the end of the century.

And I would certainly rank Japan incredibly low on most of these equal educational opportunity and employment opportunity.

I had 19 suggestions. I began to categorize them on the airplane.

Outreach, public understanding, and maybe a magazine for adolescent girls, maybe through honor societies.

Under teaching, the concept of chilliness is quite well known in certain circles. I think it was the American Council on Education had a report, and they documented certain behavior patterns, that the girls don't get called on and so forth.

And I think maybe if you started quantifying these things, the concepts are there, but if you could quantify them, then you could pinpoint areas of change and areas that are particularly outrageous.

Child care at the major graduate schools. It occurs to me those are the same places that get most of the federal funds--maybe there should be linkages.

The schools that have gone coed, and I'm curious if the girls are majoring in science or not. I suspect that they might be becoming lawyers and other things.

And I am also worried about the women's college, especially with this Gallaudet College in Washington, that they train students, but also there is an awareness that the president is a voice, has an opinion in public, matters in the public press, and that therefore if the women's colleges become coed one by one, that this whole voice will be silented as well.

I guess I am angry about the entry-level science courses. They seem to be as bad as they were 25 years ago.

You run into students that say, "So that's what they were trying to tell us. Why didn't they just say so?"

Somehow with computers and everything, it shouldn't be quite the struggle it was back then.

There's all kinds of sort of helpful groups on campus that come and go. I don't know if they need systematic funding or quite how to keep them going, but they could make a difference to a lot of people in small quiet ways.

Graduate women sometimes have support groups--practically no funding, but I think quite beneficial.

I also think advancement is a big issue, and don't know much about middle management training at national laboratories and museums, but I think there ought to be some.

Visiting positions are very good because people then get leverage back home, as well as being visible at other places.

At Cornell, in particular, and other places, they have troubles with couples. They hire one person and the other one is very unhappy. And the strategy--they tend to think that one of the couple is vastly better than the other, sort of make an insidious distinction, and then the second one is treated second rate all along.

So I somehow think systematic thinking, maybe programs, maybe a study of what is happening in various places.

I think a way to measure advancement--I see Betty Vetter back here. There are always numbers on number of degree recipients, but that's the least interesting, that's the beginning, that's entry level.

And what happens to people along the way? They may last 30 or 40 more years and somehow there is no measure to really get a grip on whether things are improving or not.

And again I think--we have the concept, but we need some kind of quantification. The glass ceiling was also a great concept of the last few years.

I think the government should be appointing more women to prominent places. There used to be woman from the National--airplane disasters--she was the first one on the scene, will be on television, and her great credibility.

I think major people shouldn't be members of the Cosmos Club, which is notorious in certain circles for not having women members, and I guess I end up favoring more research on particular areas.

Self-selection, we don't know who goes into science and why, or who drops out and why. It's usually a quiet, private decision. They might say they get better grades in certain courses and they never seem to think about long-term earnings or anything quite like that.

Sponsorship at all stages.

Evaluations of all sorts. We are all evaluating each other all the time. I think I have written 50 letters of recommendation in the last year.

Who supports?--who recognizes each other's work and pays attention? And who just is totally oblivious?

And then--since I thought you might be interested in funding, there are these Centers for Research on Women--maybe 20 of them nationwide. Most of them are fairly general, they talk about women and work, and I think it would be better if [BELL] one of them got onto science and engineering. The bell has rung--glad to answer any questions.

MR. OAXACA: Whenever I hear a story like that, you know, I always make the comment, at least you could speak English.

You know, in this country, which when most people showed up in this country, there were a lot of Hispanics in this country. To date, in the 211 years that there has been, that this country has been in existence, there has never been a Hispanic cabinet level person.

DR. ROSSITER: There's hope. The future is long.

MR. OAXACA: That's what they tell us. That's what they say when bring in the women and the Blacks and everybody. I guess only Norbert can tell a worse story than me.

DR. MALCOM: There has never been an Asian member of the National Science [INAUDIBLE].

MR. OAXACA: They're going to set up their own National Science [INAUDIBLE]

DR. ADAMS: I was going to--I was really just [INAUDIBLE] have joke to say, you said you weren't going to [INAUDIBLE].

The question that I would have to you is when will the things that I get all the time--are you telling me things are that bad?

Now, you as a female reacting to a situation--because I get it because I'm Black and, you know, it's like I'm crying. And here you--and I'm sitting here listening to the conversation today, and invariably there are people sitting around here saying, "Is that true?" You know, is it that bad?

And I'm listening to outstanding women make these kinds of critical statements today, who--professors and scientists in their own right--and that question still comes back. Is that true?

DR. ROSSITER: I'd say in private it is probably worse than you think.

DR. ADAMS: That's what I mean.

DR. ROSSITER: People want to be stoic, they put a good face on things, and when you dig in the records, it's worse.

DR. ADAMS: OK, now, sitting here where many of us sit. I'm sitting at the University of Notre Dame, for instance, and right today we're working on this very issue. We are trying to say, how can we have women and minorities participate in a meaningful way because, you know, we're not prejudiced. We are people of the cloth, we would not dare do that.

And so I come in and I'm trying to explain, but you do it every day. And they say, oh, no, not me, I wouldn't do that. What are you saying? Adams, you're too sensitive.

How can you get some of this into a language of understanding where we can raise this up, because we have been talking today about commitment and catalysts and those kinds of things.

You are talking about moving major institutions, major federal agencies that have never--you know, they don't do this. See, the President will tell you he's color blind. He doesn't want to, you know, he's color blind, you know, he's very religious, you know, he's committed.

DR. ROSSITER: Well, history is one way. I mean people will read biographies, people will read histories, it's not quite as threatening as one on one, saying, you, yourself, are discriminating.

It's sort of in the past this happened, and these people would say, yeah, yeah, that sounds like what's still happening, and it sort of creeps up on them from an unsuspecting angle.

MR. OAXACA: Any--oh, Shirley--Dr. Hanshaw

MS. HANSHAW: Mrs. Hanshaw. I would like to, if I may, indulge myself with a personal dilemma with regard to the Cosmos Club. The Cosmos Club was founded in part by John Wesley Powell, a very famous geologist.

John Wesley Powell also founded the Geological Society of Washington, which has met at the Cosmos Club for more than 110 years.

I am the incoming President of the Geological Society in Washington, and I am really wondering whether the Cosmos Club will throw us out, because of my presidency.

DR. ROSSITER: Are you the first woman president?

MS. HANSHAW: Yes.

DR. ROSSITER: I though you had one in the 1970s?

MS. HANSHAW: No, no, there has never been a woman president of the Geological Society of Washington, but, you know, it is a grand tradition in many ways. We have also--the Geological Society of Washington has looked for another meeting place because there is a great deal of resentment on the part of the women geologists who are part of that society meeting at the Cosmos Club.

DR. ROSSITER: One of my thoughts was that influential women should take heart, and sometimes they are sort of timid and they don't want to stick their neck out and when they get to prominent places, they really ought to. Get some publicity, people notice, some people notice.

MR. OAXACA: Dr. Shirley Malcom.

DR. MALCOM: Well, one of the things, the comment that just took place prior to the last dilemma that was explored here, was the whole question about reading history as a way of kind of taking the edge off of the problems that already exist.

I happened to be sitting in the library at AAAS yesterday, and there was a book in front of me that said, "Nobel Prize Winners." So I pulled it out, a big thick one, pulled it out, and I was flipping through the pages, and saw the story of Maria Gopert Mayer.

And Cornell, right?--wasn't she, didn't she spend some time at Cornell and then at Johns Hopkins--and then at Johns Hopkins.

And the kinds of dilemmas, that she never could have a real faculty position or an office or anything, even though she was a Nobel Prize winner, but, you know, you couldn't do these things.

Now, a lot of people will say, Margaret, that this happened back when, OK, and they will read your book and it says, "Strategies and Struggles"--or "Struggles and Strategies to 1940."

My question is, where is strategies and struggles since 1940?

DR. ROSSITER: A lot of people are working on it. The materials are immense. I mean even just government agencies would be immense, and there's all the universities and thousands of women.

And I might say about Maria Gupert Mayer, if you talk to people who were at Johns Hopkins in 1930 when she arrived, they would have thought they were nice to her. They would say, we didn't treat her any differently. She was a wife. We gave her an office, that was pretty good. And it's by hindsight you think it's a little bit outrageous, and she didn't protest. It's usually good girls who don't protest, very stoic, put up with whatever they get and they do outstanding work.

MR. OAXACA: Thank you very much for your testimony. I would like to ask Dr. Gerald Holton, who is Professor of Physics at Harvard University and the author of "A Nation at Risk."

Thank you so much for taking the time. You are our last scheduled testifier, and then we will go into the three minute testimony by three people. Thank you so much for taking the time, and you are following a tough act.

DR. HOLTON: Dr. Rossiter is always a very tough act to follow, and I'm glad that you said it and I didn't have to say it.

It is a great honor to be asked to speak before you. The report of your Task Force will be of immense importance to American science and engineering, to schools, to colleges, to commerce, to national security.

But it can and should go beyond that. As I hope to suggest to you, it should also be part of the dialog of what kind of a society we shall have and what kind of a people we shall be.

I have been asked to address two topics, the first concerns the lessons I might bring to you from my experience as one of the 18 members of the National Commission on Excellence in Education, whose work over the 19 months period resulted in the report, "A Nation at Risk" in '83.

What was there about our approach which resulted in certain accomplishments? What was left undone? And what might now be achieved if one gets going and rolls up one's sleeve? And this is, I think, what you should be particularly concerned with.

My second topic, which I think I cannot really cover also in those few minutes, but which I will respond to in questions if you are interested, deals also with the charge which Congress has given you, namely, over a year ago, I started a research project, which is called "Project Access," sponsored by the Office of Naval Research and initiated in cooperation with the Bunting Institute here at Radcliffe.

My first motivation was that after a long pulling and hauling, we still have only eight percent of the new Ph.D.s in physics to be women, and in our own faculty, it has been extremely difficult to get women aboard.

It is a detailed study, our project is, of how obstacles especially rise up before women who wish to become research scientists.

For example, it was mentioned here, whether they did get to be members of the lab teams during their crucial graduate work.

As the powerful editorial of last week's Science journal agrees, a major point in the attrition of women in science occurs after graduate school, just when the personal and national investment has reached its maximum.

Previous attempts to understand this have been largely unsuccessful. We have now the first results of the survey at hand, and I am hopeful we can dispell some of this ignorance.

Now, to the first topic. I assume you have looked at this booklet, "A Nation at Risk." I hope you also read the last three chapters of Mr. Bell's book, The Thirteenth Man, the U.S. Secretary of Education, who set us up as a commission at the request of the President.

I have also published an account of my own experience, at my own views, in the journal Daedalus in the fall of '84. I will hand these over to your secretary.

Now here I can really only list the chief points that can be of some use to you. First of all, and most obviously, as already has been mentioned this afternoon, you have got to let the facts take over and challenge your initial presuppositions.

Let the data push you, as our commission was pushed, yielding a unanimous report in that case. I expect that many of my fellow commissioners, appointed by the new administration in 1981, initially may have agreed with the agenda which President Reagan set out for us in our first meeting with him in the Cabinet Room.

He talked about private schools and concentrating on good educational practices examples to proliferate at low cost, and so on.

And in the end, we respectfully, but unanimously, concluded that the perilous state of American education requires a different set of solutions.

Some of you too may have to give up your initial presuppositions if you listen to the data. They are that bad.

Point two, be specific about each program which you recommend. Include a reasonable price tag. The one major concession to get unanimity in our commission was that we did not give an estimate of the funds realistically needed for our recommendation.

I greatly regretted that. Perhaps we should have had a minority report after all. Luckily, the NSB, the National Science Board did put out a good report, called "Educating Americans for the Twenty-First Century" in '83, which you should read

It estimating the total cost of recommended federal initiatives for the first 40 of implementation to be $1.51 billion in '83 dollars.

In addition, it recommended a number of other programs without giving a price tag. You should reconsider this, and also some of the more recent reports. There is an NSF report called "Opportunities for Strategic Investment in K to 12 Science Education," put together by SRI in June '87.

It asks for $1.2-1.5 billion, spread over a five-year period, just for pre-college. The National Science Board also has a report on what it takes to have undergraduate education. Look at that. It has its price tag.

Now, I believe that you should come out with substantive and financial recommendations, and I invite you to also find out why so far many of these [INAUDIBLE] proposals have failed to be implemented and some have sunk from sight as if torpedoed.

How will you prevent this from happening to your report?

The third point on my list of consideration concentrates especially on big leverage items. We concentrated on perhaps too many, and we did not say that all of them are really needed to make sense.

For example, we talked about the life of the teacher having to be improved. That was certainly a very important part. It remains to be implemented.

We also talked about the need to upgrade and strengthen the state and local high school graduation requirement. That was widely adopted.

But you can't only do one without the other. You have to have a coherent plan. You must insist that it not be broken up into incoherent pieces.

Point four, so far I have spoken about the individual items, so to speak, the tree. Now it is equally important to keep the whole forest in view.

Of course, better programs are called for to assure the underrepresented groups have access to science careers. You must speak clearly and strongly about it. This includes set-aside programs, of course, but you mustn't stop there.

To do so would greatly reduce the power of your conclusion and your appeal to the mass of allies that is really waiting for you out there.

Put your particular case into the context of the general national need. Use the largest interpretation of your mandate.

For example, I am troubled that we keep linking all our educational problems nowadays with the threat to productivity of U.S. industry, serious though it is.

I would be equally troubled if you dealt only with the problem of women, minorities, and the disabled, serious though they are. Yes, the science deprivation of women students is most serious, starts earlier, but 40 percent of the elementary classes in the U.S. have no science material or equipment for anyone [INAUDIBLE].

Gender is a major predictor of career choice, yes. And If a girl in seventh grade decides not to go into mathematics, the door to science begins to close on her more than on boys.

But as the National Assessment of Mathematics found, when you talk about all 17-year-olds, male or female, 40 percent of them can't find the area of a square if you give them one side. [laughter]

Yes, a study we are doing in [INAUDIBLE] physics has shown that women, on the whole, get much less adequate mentorship during their graduate years than they need. But it is also true that the number of graduate fellowships for men and women is a small fraction of what used to be available, and which is needed now.

And to make matters worse, graduate stipends are now being taxed.

Remember a lesson of the civil rights struggle in the 1960s. It finally began to succeed when it dawned on enough people that at bottom the plight of the Blacks was not a black dilemma but an American dilemma.

Similarly I am saying, to a significant degree, the underrepresentation and other distress of the groups that you are concerned with and I am concerned with, are the byproduct of the general distress of the current educational system.

They are the costs of the shameful incompleteness of the old American dream that for everyone, talent and willingness to work should count for everything when competing for access to education.

[INAUDIBLE] I suggest that the GI bill after World War II is a kind of example for you to consider with pre-college years added.

Therefore, I say, yes, more of the underrepresentives should have access to science [BELL] for the sake of increasing our efficiency and competitiveness, and even military preparedness, but equally and perhaps more importantly, they should be enabled to do so for the sake of simple social justice, for the sake of the quality of life as Americans, and even as a test of what a modern, well-functioning society should be like.

I am convinced the majority of Americans are ready to hear this kind of talk from you.

Now, just a few final comments. I think you must be clear what is federal responsibility, because you are living in an age of privatization. The federal government must take on responsibilities it does not like at the moment or perhaps for some time in the future. We had the courage to add, quote, "We recommend that citizens across the nations hold educators and elected officials, all elected officials, responsible for providing the leadership necessary to achieve the reforms.

Their track record should be remembered in the voting booth.

Finally, in your report, insist on accountability, at least keep some visible, credible bipartisan watchdog going, possible on the model of the National Education Council proposed by the NSBoard, the National Science Board, for the report of '83.

Try to stay in business. Our commission requested that but was not given the opportunity to do so.

Provide a report card from time to time to the

American people and to the President.

Arrange to respond to comments on your report, and in closing, I repeat, if you support is strong, and it's framed within the total need of the U.S. in a way every American can understand.

It can help to decide what kind of society we shall have.

Let me thank you for your attention. I wish you a good [INAUDIBLE].

MR. OAXACA: Thank you, Dr. Holton. [Applause]. Yes, Ms. Winkler.

MS. WINKLER: Thank you. I'm from the Department of Education. "Son of Nation at Risk," called SONAR is in draft. I haven't seen it yet, but I'm that will be interesting, too.

One question I have for you--I guess we're getting very close to the point where we really have to think about the things that you are laying out for us here.

How many recommendations should we have? Should we have five, 50, 100, 12, what?--realistically.

DR. HOLTON: Well, you are now asking me to give you an editorial suggestion.

MS. WINKLER: Exactly.

DR. HOLTON: My editorial suggestion is keep it a small booklet like hours, 10,000 words, 31 pages in big type. There are other things you can publish separately.

Group your recommendations into four or five things.

Psychologists have shown that people can't keep more than five things in mind at any one time, and I asure you I have trouble with five sometimes.

Under each of the major recommendations, you can have subsections and we have had all together 40 recommendations under six or so total headings. But it is also important at the end to produce a warning that this is not a multiple choice test. It is a coherent plan, rather than a set of alternatives.

MR. OAXACA: Thank you so much. Oh, Dr. Mike Rios.

DR. RIOS: Dr. Holton, you alluded to something that has been concerning me quite a bit. During the course of our hearings, we have heard quite a few recuring themes that are the symptoms of something that needs a remedy, and yet I find it quite difficult, really, to translate that into a set of specific action items.

And furthermore, it is a concern of mine as to the dollar cost, in other words, whether it is pragmatic or not. If I understood you correctly, you said that we should be specific in terms of dollars.

DR. HOLTON: Yes.

DR. RIOS: I don't see that as being feasible, and maybe my federal Task Force members disagree with me, but I think that when you put dollars to something it needs a great deal of analysis and preparation, and I don't see that that is necessarily the charter of the Task Force if it is to be done properly.

It seems to me that the ultimate policy must be in terms of the dollars, but the recommendations have to be such that an administration is either going to embrace a strong action item and implement a policy.

Do you think it is feasible to do a really meaningful plan, that is the structure for policy, and that includes meaningful dollars and rechanelling and earmarking of dollars within federal agencies?

DR. HOLTON: I believe it is, and I believe it is necessary that you make an attempt--and I don't think the attempt is going to be all that difficult.

First of all, as I indicated, much of the homework for science has already been done, at various levels. It has to be done for undergraduate education, or pre-college education, and to some degree for education beyond the college level.

So at least get those data. There are other items which have not been researched, such as the suggestion that there should be more science television for children.

But I believe that if you do look around, people are ready to give you estimates, and I think at least estimates should--clearly label this estimates, and given the credit of where they come from should be cited.

People should have, and Americans like to have a feeling of what it look. Beyond that, don't be scared that it will be a big bill.

Let me tell you that I have in mind an editorial in the current issue of the American Journal of Physics, in which the physics community, I think, is quite well represented by saying, what this country really needs for education in science and related fields, is a kind of Marshall Plan.

The Marshall Plan cost $12 billion in 1948. Over four years Europe was rescued from the threat of having another Hitler or Stalin. We didn't do it after the first war, and we regretted it very badly.

Twelve billion dollars in '48 dollars come to $60 billion now, spread over 10 years, a $6 billion dollar a year add on of a concentrated kind to reach the kind of goals that you wish is something which is doable, and which, in fact, is a small fraction of a number of fantasy projects that you can name.

So that I believe that you should be specific and you should be clear that here is reality, and that this is a better way to spend our wealth than on certain fantasy projects which do, in fact, get the money now.

MR. OAXACA: Dr. Holton, how much would you conclude is--to me, as a businessman, and reading Secretary Bennett's write-up that the U.S. spends $300 billion a year on education,. I gotta believe that the numbers that the numbers you are talking about could be fitted in well within the reallocation of resources, for all the money you are literally sending down a rathole, in the way it's being done right now.

There is the big issue of teacher accountability. There is the issue of paying teachers for performance. There is the issue of demanding of our parents and of our children, that they recognize that you gotta start on day one.

Is it more of an assessment of how you reallocate a huge amount of money that's being put out there to support a lot of organizations in the educational, huge bureaucracy that has, really has no useful purpose.

I'm a child of the Proposition 13 in California, which Howard Jarvis saved me from having to pay $9,000 a year property tax, as opposed to $900, and they said that the whole place would collapse and go down the toilet, and it was interesting to note that at that time in California, the first thing they said was that we're going to have to lay off all these teachers, and we are going to have to add people to the administrative side to manage the layoffs.

And when the smoke all filled and the school boards got in charge there, and they said, we don't need all this administration, what we need are teachers. And when the smoke all cleared, you probably have a more efficient school system now by that reallocation of resources.

So, what are your views on this reallocation of resources?

DR. HOLTON: I'm glad to respond, Mr. Chairman. I think that the way to think about it is that there are certainly costs that can be saved in the educational system, as in any other system.

I want to draw your attention, though, that the number that you have quoted, and which Mr. Bennett often does quote, refers in largest part not to academic programs. There is a great deal of money there, which has to do with aid of the kind that used to be either forgotten about or provided by families.

It is very often a rescue program for an underclass, and I would be very scared of blindly saying to the educational community that they will have to just simply find the money somewhere, and I am afraid where it is going to come out of, not from the strong bureaucracy, I'm sure.

I rather say that the place to look for savings is in the trillion dollar budget of the U.S. federal government, rather than in the total budget, local and federal, of the educational community.

You have really to do two things, one is to decide what you want. If you really want it badly enough, find a number. If you want that number, insist on it.

And secondly, let someone decide what else is not good enough and should be turned off if you can't afford it.

MR. OAXACA: Thank you so much for your testimony and thank you again for your time.

We now have 12 minutes, three minutes--I mean nine minutes, three minutes apiece for the folks that want to testify. We thank you for staying here late. I would like to ask Ms. Janice Button-Shafer, Professor of Physics, University of Massachusetts in Amherst, who is with the American Physical Society Commission on Status of Women in Physics.

DR. BUTTON-SHAFER: Thank you. Could I use the transparency projector?

MR. OAXACA: Sure, just let me please remind you that we need you to describe everything you put up there. Thank you so much.

DR. BUTTON-SHAFER: I guess there's no microphone but I'll speak loudly. I was trained in the late forties, early fifties, both in engineering and in physics, and also in nuclear particle physics.

I come here as a representative not only of the University of Massachusetts, but as you indicated, the Committee on the Status of Women in Physics.

Now this is an outline. I will cover just a little bit about--I'm sorry, it's not very large--but I will cover a little bit about the history of this committee with the American Society, Physical Society.

The status of women, I have a few graphs, the activities of this organization on the status of women physicists, and finally, a few suggestions.

We are functioning under the auspices of the American Physical Society, as indicated. We have 10 or 12 members, including a Black woman physicist and three men. We come from a variety of disciplines.

In 1971 the committee was established under the auspices of, I will call it APS, the American Physical Society, at the request of Professor [INAUDIBLE] of MIT, 10 years later in '81, there was started a newsletter, known as The Gazette, to try to give support to women physicists and also to acquire data.

Now here I would like to take up my second item, which gives you some data on the number of bachelor of science degrees awarded each year to women in various fields of science and engineering.

I wish to point out that mathematics in 1970 was a little below 40 percent, has climbed slightly to as high a figure as 44 percent women getting bachelor's degrees.

Biological sciences started lower but has matched mathematics and is still climbing.

Chemistry, physics, engineering, we've gone from one [SOUND OFF FOR OVER TWO MINUTES], strain are much higher in the percentages of women, and indeed in the percentages of women faculty, as high as 10 percent or greater.

This is from '62, careers for women in physics. The committee did not yet exist. When the committee [INAUDIBLE--TECHNICAL DIFFICULTIES] a few years back and we are updating that.

Now I would like to--skipping this material on the symposium--tell you that we have, as another function of our committee, a liaison group, of which I am the chair, functioning with three members providing data, a match between candidates and positions to try to put women in senior faculty posts across the country.

Steve Weinberg, a one-time college contemporary of mine, and Alan Grande, Joan Quinn, [INAUDIBLE], who are Nobel Prize winners, deans, heads of departments, are playing an advocacy role as a prestigious panel to try to put more women into tenured slots.

This, however, has not been functioning very long and we are feeling a little gloomy as of now for reasons that you may be able to guess.

This comes from an MIT publication, their technology review. It is just one of a number of entries from this, an issue of about a year, a year and a half ago.

MR. OAXACA: Would you read that, please, because there are people which are unsighted.

DR. BUTTON-SHAFER: Sorry. This is from Technology Review, November-December of '84, "High Energy Physics: A Male Preserve." This is an article written by a young woman anthropologist who had studied various high-energy physics, particle physics laboratories for 10 years.

She says what she has observed is that traits required for gaining entry into this exclusive community, aggressive individualism, haughty self-confidence, and a sharp competitive edge are traits typically defined as masculine by our society.

As one long-term observer remarked, quote, "Only blunt, bright bastards make it in this business," unquote.

Finally, I had something from Betty Vetter. I am worried about what has been published and remarked on by her, perhaps most recently in '87, Mosaic, spring of '87.

She says that, "Despite persistent inequality of opportunity for women in science and engineering, both in education and employment, numbers are tapering off. Recent gains may not endure.

Item four, and my final section. We have been doing some things in western Massachusetts. We have what we call the five-college, including U Mass, Amherst, Smith, Mount Holyoke, and Hampshire College, a partnership with public schools, and there has been an annual physics teacher workshop, with not only talks but also some hands-on demonstrations.

There is a Massachusetts Association of Science Teachers, and I have become somewhat involved in talking with physics and science teachers on a few occasions.

This was a statewide meeting, October of '87, bringing science teachers from all over the state, and we have in fact a symposium at the University of Massachusetts that we have had annually for about five years now.

My final transparency, going back to what I started with, gives you just a few remarks that we must have encouragement for girls in high school and pre-high school years.

Girls need to be exposed, not only to scientific ideas but to apparatus at young ages. We do not, incidentally, have enough women experimenters making it into university faculty level posts.

We need mentors--this has come up over and over again for young girls, and in fact, for university students and beyond. Millie Dresselhaus has described the inspiration she gained from Rosalyn Yallow at Hunter College, where she was an undergraduate, and from Maria Gupert Mayer at the University of Chicago, when she was a graduate student.

Summer camps may be a possibility. These, of course, have been held in a few places. I would advocate more physicists involvement in setting up these camps, and our committee hopes to do something on that.

And we have heard from other people about the special summer institutes that have existed, either for high school teachers or for students.

I will have some reference material and some written reports...

MR. OAXACA: Thank you so much for your testimony. I would now like to ask Ms. Karen Henry, research civil engineer, Society of Women Engineers, the U.S. Army, and you will have to explain what CRREL means.

MS. HENRY: First of all, I would like to thank the remainder of the Task Force for staying for my testimony.

CRREL means Cold Regions Research and Engineering Laboratory.

I am testifying today on behalf of two groups of women technologists, the North Country Section of the Society of Women Engineers, and the Women Engineers, Scientists, and Technicians at CRREL, where I am employed.

The North Country Section of SWE has found two activities to result in a successful recruitment of qualified women high school students into engineering.

The first if merit awards, for three or more years of outstanding performance in science, mathematics, and citizenship.

The qualifications of recipients to become engineers are highlighted when the award is made, and this simple recognition has resulted in at least one individual changing her college major to engineering.

Unsolicited feedback has also proven the success of teaching young women what engineers do. We sponsor career days and in-class presentations with ourselves as role models.

My own career choice is a direct result of such a career workshop.

The rest of my testimony deals with the most critical aspect of being able to combine a technical career and parenting, that of the care of our children while we are at work.

CRREL permanently employs 22 women in science and technology positions, 10 of us are mothers. With one exception, all of us have children requiring care during the day. The one who doesn't is involved in caring for her 90-year-old father.

A critical shortage of adequate, affordable child care is negatively affecting us, our families, and our careers. Five of us had babies in 1987. We all sought suitable day care for our children for over one year.

Presently, some have only part-time slots at day care centers, forcing curtailed working hours. One woman leaves here baby with a friend who has no phone and no car. My son has had four caregivers since I returned to work in September. Two situations were temporary, and my current option ends next January.

Most of our technicians cannot afford to pay the going rates of $2-3 per hour per child at licensed centers and can only use private care givers.

Single parents and parents of more than one preschooler are barely making ends meet financially. We are forced to use annual leave to take care of our children when they are sick, most of all of which was depleted while we were on our, quote, unquote, "maternity leave."

We have been trying for two years to start an on-site day care center. All we need are funds to construct a building. We can handle the operating and maintenance costs.

Our proposals are turned down because our laboratory, which employs over 300 people, is considered too small.

The bottom line is that we are tired, we are broke, adn we are very nervous about the future of our children.

If the federal government truly cares about the careers of women in science and technology, something must be done about our current child care situation.

Thank you for this opportunity to share the concerns of many of the women where I work.

MR. OAXACA: Thank you so much for your testimony.

MS. HENRY: You're welcome.

MR. OAXACA: You're not alone in bringing up that as an issue.

MS. HENRY: Great.

MR. OAXACA: And right after this, we'll have a session with the Task Force because we are on until 11 p.m. tonight in trying to get the groups together, so I will be briefing you on that.

Welcome to the Task Force and thank you for staying here so late.

MS. DOHENIAN: Well, I'm grateful that you all are staying not only this late but even later to work on this problem. [BELL] Already?

Today, you have been hearing about the crisis in science literacy in the United States. International surveys conducted by the International Association for the Evaluation of Educational Achievement, as association of research centers, demonstrate the poor performance of U.S. students compared to their counterparts across the world.

For a technologically advanced country, it would appear that a re-examination of how science is presented and studied is required.

The fifth grade level, the U.S. ranked eighth among 15 countries surveyed. At the ninth grade level, U.S. students placed 15th in a field of 17 nations, with only Hong Kong reporting poorer performance.

Among high school seniors pursuing a second year of study in biology--those students we consider to be advanced placed and science specialists--the U.S. placed last, with an average mean score of 37.9 percent.

The same survey also measured the performance of female versus male students in the sciences. In the U.S., the higher the grade level, the greater the discrepancy between boys and girls.

Science museums across the country are concerned with the various ways in which they, as informal science education centers, can address the national problem of science literacy.

While today's world is one of fast-paced science and technology, surveys show that over 90 percent of all Americans are scientifically illiterate, that is, they have little or no understanding of basic scientific principles.

High technology--America's hope for the future--is intellect intensive.

Knowing the extent of this problem, those concerned must re-examine the potential solutions and how our own efforts can be effective in reversing this trend.

Although tremendous effort and resources have been poured into solving science literacy on a higher education level, not enough has been done to cure the root of the problem, the lack of science education in elementary schools.

It is obvious that young children in the U.S. are no less curious than their counterparts in other countries. In their early years, children are natural scientists, always exploring and never hesitant to ask questions. You can ask any parent in the room.

It is at these young ages that the changes must first be made. By the time students are in the eighth grade, only 20 percent of the entire student body is interested in science.

Among women and minorities, the statistics are even more alarming. Many elementary schools are devoid of science curricula. Young women and minorities who are rarely reared in an environment where they are motivated to excel in science are hurt the most.

Most girls and minority students have fallen behind in science achievement and will not choose to study science in college.

Experts cite three principal causes for the poor showing of women and minorities in the sciences--social-cultural-economic constraints, lack of academic preparation, and an inadequate supply of role models.

Young women and minorities need to be drawn into the world of science at an early age when they are formulating their interests and ideas about science.

In 1985, the Boston Museum of Science began a collaboration with the Campfire Organizations on Camp-In Program. The Camp-In Program is one of the innovative programs developed to address the science literacy problem, particularly the deficit of women and minorities in the field.

A Camp-In is an overnight [BELL] camping experience at the Museum of Science designed primarily for girls in grades one through eight. Campers arrive in the late afternoon, explore the museum's exhibits, participate in a variety of educational activities, then spend the night sleeping in the exhibit halls.

Some of the organizations which attend the Camp-In include the Girl Scouts, Camp Fires, school and church groups.

While 85 percent of the participants are girl groups, Boy Scouts and some coed groups have also attended Camp-Ins. The purpose of the Camp-In program is to introduce young women to science at an early age, to show them that women do study science, that science is a career option, and that science is fun.

During a Camp-In session, girls become familiar with science through hands-on science workshops, activity stations, Omni and theater electricity shows and live animal and science presentations.

Campers come from all over New England, and as well as New York and Pennsylvania.

The majority of the Camp-In staff are women. In addition to paid staff the museum utilizes the tremendous resource of local women and minority scientists who volunteer their time to teach at Camp-In nights, providing ideal role models for girls and minorities.

To continue this experience beyond the first weekend a Camp-In patch is distributed, providing campers with free admission to the Museum of Science for one calendar year following their Camp-In overnight.

The purpose of the patch is to extend the science learning experience beyond the single Camp-In night. The patches are highly coveted by the campers.

The impact of this program is already evident. In 1986-1987 the Camp-In program had 27,000 participants. Response from Girl Scout troops has been overwhelmingly positive.

The Plymouth Bay Girl Scouts reported a 700 percent increase in the number of science badges worked on during 1986-87.

Other museum programs exist to address the same issue and to follow through on the commitment we have begun with these young children as they grow. One third of the Boston Museum of Science's Internship Program, which is supported by the Boston Foundation, have been minority students.

Our Elementary Science Outreach Program is currently serving eight AFDC communities.

In 1988, a Science by Mail Program was begun, giving students, families, and school groups the opportunity to creatively solve three scientific problems yearly.

Their answer--which is mailed back to the museum, making this accessible to people who can't afford admission, or cannot physically get to the museum--will be forwarded to over 100 volunteer scientists for examination and suggestions for further exploration.

Initial response to this program has been overwhelming. The scientific community has responded from across the nation to support and participate in this program.

Indeed, a few of these scientists are individuals who chose to pursue careers in science as a result of participation in this participation in this particular museum's program when they were children and young adults.

This program is the first of its kind in the U.S. and is specifically designed to motivate students who were never interested in science before, by showing them that scientists are human beings like themselves who started by asking questions and looking for answers.

Science by Mail makes science available to students in grades four through nine who cannot come to the museum's facility.

Four percent of the participants are on scholarships, since no one who wishes to participate is turned away for lack of funds.

Designed to serve the New England area, the museum is finding participants as far away as Alaska, Europe, and the Mediterranean.

The growth and expansion of the number of science centers, as reported by the Association of Science and Technology Centers, is continuing. Fifty-eight percent of the existing science museums were established since the 1960s, the post-Sputnik era.

In the 1980s, 20 new museums were developed with the establishment of new science museums continuing nationally in the coming decade. These science centers are starting up in medium-sized towns, not just close proximity to big cities.

The annual national attendance of 44.5 million visitors attests to the increasing popularity of science museums, and it also puts pressure on us in terms of increasing opportunity.

Five out of ten of these visitors are 17 years of age or younger. The opportunity to make an impact on science illiteracy abound, as the community comes through our doors.

Science education programs conducted by science museums throughout the U.S. reached 10 million young people a year, both through workshops held within the museums themselves and outreach programs.

One hundred of these museums also conduct teacher workshops, reaching 65,000 teachers yearly, so they might take new tools and techniques for teaching science back to their filled classrooms.

It is a growth industry. Science museums are directly involved with the schools, with the teachers, and with the young children who will be an answer to the nation's problems.

MR. OAXACA: Thank you so much for your testimony. A bit of information for Mrs. Karen Henry. One of the very distinguished members of this Task Force, Mrs. Jill Emery, who is with the Department of Labor, handed me a note that says the Secretary of Labor, Ann Gore McLaughlin, in recognizing the importance of child care as it affects working women, has formed a departmental task force, which she personally chairs.

And they are coming out with that report on April the 14th. And I don't know what the report will say or how it will address the issue, but at least somebody in the front office is, you know.

MS. HENRY: Thank you for the information. My current child care option is going to be ending and--my current child care option is a [INAUDIBLE] an au pair which we obtained through one of the two au pair programs, but [INAUDIBLE] and I know Ann McLaughlin is presently not in favor of the au pair program as it stands. So that is why my current child care option will be ending in January.

So I'm very interested in the other options.

MS. EMERY: We need to check our facts on that one, though, because I...

MS. HENRY: Pardon me.

MS. EMERY: We need to check our facts on that one because I thought just what you were thinking and I was told I was wrong, so we can.

MS. HENRY: Oh, wonderful.

MS. EMERY: If you give me your card, I will be sure and happy to drop you a line about that.

MR. OAXACA: This concludes the testimony. Let me thank everyone for their participation and for the very timely input. We're trying to come up with our interim report in time to impact the great political activity that's going on.

We have gotten a significant number of good inputs that we can address, and as far as staying in business, which Dr. Holton mentioned, the strategy behind coming out with a report in between in that we are in business until the end of '89, and hopefully, if we get it going now, we can move from there.

Any witnesses that can stay, we would be delighted to have you, so that some of the Task Force members can chat with you if they have any particular further questions.

In the meantime, let me quickly say that the boss, our Executive Director, Sue Kemnitzer, says that by 11 o'clock tonight, we have to get the inputs in from the group leaders, and the group leaders which we're breaking up in a different cross-section this time to handle American Indians, Blacks, disabled, Hispanics, and women.

Let me mention who the group leaders are that have to get their teams together to once again go over draft number three.

That's Norbert Hill for American Indians, Ferial Bishop for Blacks, Jim Biaglow for the disabled, Ernie Reyes for Hispanics, and Joanne Brasel for women.

And so, do it in the way that makes you more comfortable, over dinner, over a glass of wine, or...

MS. BISHOP: Question. Sue, have you appointed members to the various groups, or...

MS. KEMNITZER: No, this is a self selection process. So if I would ask the Task Force members to, at this time, approach the group leader whom they would like to work with tonight.

And my room number is 705, and I ask you to bring your comments, either as a group or just designate whomever would like to come this evening. Thank you.